NASA Contractor Report 3122

Computer Programs for Calculating Pressure Distributions Including Vortex Effects on Supersonic Monoplane or Cruciform Wing-Body-Tail Combinations With Round or Elliptical Bodies

Marnix F. E. Dillenius and Jack N. Nielsen

CONTRACT NAS1-14495
APRIL 1979

NASA

NASA Contractor Report 3122

Computer Programs for Calculating Pressure Distributions Including Vortex Effects on Supersonic Monoplane or Cruciform Wing-Body-Tail Combinations With Round or Elliptical Bodies

Marnix F. E. Dillenius and Jack N. Nielsen
Nielsen Engineering & Research, Inc.
Mountain View, California

Prepared for
Langley Research Center
under Contract NAS1-14495

National Aeronautics
and Space Administration

Scientific and Technical
Information Office

1979

TABLE OF CONTENTS

SUMMARY

Computer programs have been developed capable of calculating detailed aerodynamic loadings and pressure distributions acting on pitched and rolled supersonic missile configurations which utilize bodies of circular or elliptical cross section. The applicable range in angle of attack is up to 20°. Mach number may range from 1.3 to about 3.0.

The theoretical approach described in this report is based on representing the components by three-dimensional singularities associated with supersonic, linear flow theory. The body with circular cross section is modeled by a distribution along the centerline of supersonic line sources or sinks to account for volume effects and supersonic line doublets to account for effects of angle of attack. If the body cross section is elliptical, supersonic body source panels are placed on the body surface accounting for both volume and angle of attack effects. Constant u-velocity panels are distributed over the lifting fins or wings to account for lift. Fin thickness is modeled by planar source panels. The fins may be arbitrarily deflected. In order to account for fin-body interference, a shell with constant cross section is placed around the body over a length equal to the fin rootchord. Constant u-velocity panels are distributed on this interference shell to account for lift carryover onto the body. Behind the trailing edges, fin-body interference is accounted for by the inclusion of the effects of fin trailing vorticity, determined from slender-body theory, in the calculation of body pressures. Body nose vortex shedding is modeled by potential flow vortices whose strengths and positions in the cross flow plane are determined from an analytical-empirical approach. If the body cross section is circular, the body nose shedding vortex data is built into the main program. For bodies with elliptical cross section, this data is input to the body flow modeling program and must be determined from other means. Body nose and canard fin vortex paths along the configuration are calculated by the

vortex chasing program based on slender-body theory including effects of fin deflection.

Over the body nose section, the calculated pressure distribution can include effects of vorticity shed from the body nose. Through the canard or monoplane wing section, the pressures acting on the body and lifting surfaces can be influenced by the body vortices as they travel along the body. From the canard to the tail section, the body pressures can be affected by body and canard fin vortices. The effects of the vortices may also be included in the calculation of the loads on the tail fins.

A description is given for the procedure required to calculate, in a series of steps, pressure distributions and loadings acting on complete configurations. Two calculative examples are shown. The first case involves a cruciform canard-body with circular cross section-cruciform tail. The second case is concerned with a monoplane wing-elliptical cross section body-interdigitated tail configuration. The computer programs are described and documented in the appendices of this report.

1. INTRODUCTION

Methods for computing the supersonic pressure distributions on missiles having monoplane or cruciform fins or missiles with bodies of elliptical cross section are not well developed, and much work is required to produce programs that can be used for design purposes. It is the purpose of the work reported here to extend an existing three-dimensional, supersonic, lifting-surface computer program to include various options required for missiles of the above types. The work was jointly supported by Langley Research Center and the Air Force Flight Dynamics Laboratories. Langley technical directors were Wallace C. Sawyer, Raymond L. Barger, and Jerry M. Allen; Air Force technical director was Calvin L. Dyer.

Before describing the extensions to the preexisting program, a brief description of it will be given. The program was developed under ONR sponsorship and is described in references 1 and 2. In reference 1 supersonic planar or cruciform wing-body combinations with round bodies were treated, and fin loadings were determined using panel methods and linear theory. No vortices were included, and a tandem set of lifting surfaces was not covered. In reference 2 the full Bernoulli pressure equation was used in determining fin loadings. The paths of vortices behind cruciform fins were studied for a cylindrical afterbody using both slender-body theory and the full wave equation. It was decided that slender-body results were sufficiently accurate. Provision to account for specified nose vortices on the fin loading was included. Preliminary leading- and side-edge suction calculations were implemented for the purpose of modeling separation vortices from the leading- and side-edges of the fins using the Polhamus vortex lift analogy described in reference 3. Furthermore, the effects of body nose and canard vortices on the cruciform tail were determined. The applicable range of included angle of attack was increased to about 20°.

The additional scope of the present report covers extensions to the computer program of reference 2 to two missile types, cruciform wing-body combinations with an axisymmetric body and a combination with elliptic body cross sections, monoplane wing and cruciform interdigitated tails. With regard to the first configuration the following items have been added to the computer program:

(1) Add option for determining body nose vortex characteristics explicitly.

(2) Calculate body pressure coefficients for entire missile.

(3) Explicitly determine the positions of all vortices at the canard trailing edge including nose vortices and vortices from canard fin leading edges, side edges, and trailing edges.

(4) Add an option to calculate the trajectories of all vortices over the entire length of the missile.

(5) Include effects of canard and tail fins deflection on vortex paths and fin loadings.

(6) Add option to include effects of canard fin thickness.

With regard to the missile with a body of elliptical cross section, the following tasks are addressed herein:

(1) The three dimensional, supersonic, lifting-surface computer program is to be extended to monoplane wing - combinations for elliptical cross-section missile bodies with cylindrical and boat-tailed aft ends having various conventional wing planform shapes. Pressure distributions shall be calculated including thickness and vortex effects. The resulting forces and moments are to be determined.

(2) The program is to be extended to include provisions for handling a cruciform interdigitated tail that can be located at various cant angles to the body surface. The loads on the tail fins are to be calculated including tail fin-body interference effects together with wing vortex effects. No thickness need be included for the tail fins. The fin contributions to the overall forces and moments are to be determined.

In this report the general approaches are described first for determining the pressure distributions on the two configurational types under consideration. Then a more detailed description of the approach is given with the bulk of the analytical material given in a series of appendices. Next, detailed procedures are given for applying the component computer programs to complete configurations, followed by two calculative examples. Some comparisons between predictions and experiment are then given. Complete descriptions of the component computer programs are given in appendices together with input and output format.

SYMBOLS EXCLUSIVE OF APPENDICES

a	local body radius
c	chord of a fin panel through its centroid
c_2	chord of fin panels at fin side edge
$C_m\big\|_{\text{body axis}}$, $C_n\big\|_{\text{body axis}}$, $C_\ell\big\|_{\text{body axis}}$	component moments per unit dynamic pressure along y_B, z_B, and x_B due to net effect of $C_N\big\|_{\text{panels}}$ summed over all body panels
$C_m\big\|_{\text{panel}}$, $C_n\big\|_{\text{panel}}$, $C_\ell\big\|_{\text{panel}}$	pitching moment, yawing moment, and rolling moment for unit dynamic pressure of single body source panel in x_B, y_B, z_B coordinates
$C_m\big\|_{\text{wind axis}}$, $C_n\big\|_{\text{wind axis}}$	component moments for unit dynamic pressure along $\bar{y}$, $\bar{z}$ axes due to net effect of $C_N\big\|_{\text{panels}}$ summed over all body panels
C_D	$C_x\big\|_{\text{wind axis}}$
C_L	$C_N\big\|_{\text{wind axis}}$
C_{x_B}, C_{y_B}, C_{z_B}	components in x_B, y_B, z_B coordinates of $C_N\big\|_{\text{panel}}$ summed over all body panels
$C_{x_B}\big\|_{\text{panel}}$, $C_{y_B}\big\|_{\text{panel}}$, $C_{z_B}\big\|_{\text{panel}}$	components of $C_N\big\|_{\text{panel}}$ along x_B, y_B, and z_B, respectively
$C_N\big\|_{\text{panel}}$	force normal to body panel for unit dynamic pressure, $(C_p) \cdot$ (panel area)

$C_x\|_{\text{wind axis}}$, $C_z\|_{\text{wind axis}}$, $C_z\|_{\text{wind axis}}$	components in $\bar{x}$, $\bar{y}$, $\bar{z}$ coordinates of $C_N\|_{\text{panels}}$ summed over all body panels
$C_{N_{LE}}$	fin normal-force coefficient due to leading-edge suction
$C_{N_{SE}}$	fin normal-force coefficient due to side-edge suction
C_S	suction coefficient, suction force divided by qS_R
C_P	pressure coefficient, $(p-p_\infty)/q$
$C_{P_{min}}$	pressure coefficient for vacuum
ΔF_X	force in $-x_W$ direction acting on lifting vortex element of fin panel
ΔF_{Y_1}	force in y_W direction acting on lifting vortex element of fin panel
ΔF_{Y_2}	force in y_W direction acting on trailing vortices along side edge of a panel for a distance "c_2" between successive trailing vortex element intersections with the edge
GAMT	nondimensional body vortex strength, equation (7)
K_{LE}, $K_{v,LE}$	$C_{N_{LE}}/C_{S_{LE}}$
K_{SE}, $K_{v,SE}$	$C_{N_{SE}}/C_{S_{SE}}$
M_∞	free-stream Mach number

n	summation index for all constant u-velocity panels
NCW	number of fin panels along the chord
NHP	number of constant u-velocity panels on both horizontal fins
NPANLS	sum of panels on horizontal and vertical fins
NRP	number of panels on right horizontal fin
NWBP	total number of panels on cruciform fins and body interference shell
N3P	number of constant u-velocity panels on upper vertical fin and horizontal fins
p	load static pressure
p_∞	free-stream static pressure
q, q_∞	free-stream dynamic pressure
r_b	body radius at start of cylindrical section
S_R	missile reference area
SUMFT2	see quation (24)
SUMFX	sum of all forces acting upstream on vortex elements of fin in vortex lattice structure nondimensionalized by qS_R
SUMFY1	see equation (22)
SUMFY2	see equation (23)

u, v, w — components of the flow velocity along axes x_B, y_B, and z_B, respectively

u^+ — axial velocity on outward surface of constant u-velocity panel

$\bar{u}, \bar{v}, \bar{w}$ — components of velocity V_R along wind axes corresponding to x_B, y_B, and z_B for $\alpha_c = 0$ and $\phi = 0$

v_N — velocity normal to body interference panel due to constant u-velocity panels of fins and interference shell

v_{N_t} — velocity normal to body interference panel due to fin thickness source panels

V_R — total resultant velocity at point on the body surface

v_W — velocity induced normal to vertical fin by all constant u-velocity panels of fins and interference shell

v_{W_i} — velocity induced normal to vertical fin by body axis singularities and external vortices

V_∞ — free-stream velocity

w_N — velocity normal to body source panel with orientation angles θ and δ

w_W — velocity induced normal to horizontal fin by all constant u-velocity panels of fins and interference shell

w_{W_i} — velocity induced normal to horizontal fin by body axis singularities and external vortices

α	angle of pitch, equation (12)
α_c	included angle of attack, angle between free-stream velocity vector and body longitudinal axis
β	angle of sideslip, equation (12)
γ	ratio of specific heats of air
Γ_B	strength of right body nose vortex
δ	pitch of panel about y' axis positive in direction $x' \to z'$
$\delta_{H,L}$	deflection of left horizontal fin, positive trailing edge down
$\delta_{H,R}$	deflection of right horizontal fin, positive trailing edge down
$\delta_{V,D}$	deflection of lower vertical fin, positive trailing edge right
$\delta_{V,U}$	deflection of upper vertical fin, positive trailing edge right
θ	polar angle in y_B, z_B plane
θ_s	streamwise slope of bevelled leading edge of fin
$\theta_{2,BIP}$	angle between trailing edge of body panel and y_B or y_W axis
ν	index of all control points on cruciform fin and body interference shell
ϕ	roll angle of missile, positive for clockwise rotation looking toward the nose

x_B, y_B, z_B	Cartesian coordinates fixed to missile with the origin at the body nose tip; x_B is positive rearward, y_B is positive to right looking forward, and z_B is positive upward
$\bar{x}$, $\bar{y}$, $\bar{z}$	wind axes corresponding to x_B, y_B, z_B when $\alpha_c = 0$, $\phi = 0$
x', y', z'	set of axes obtained by first rotating y_B and z_B about x_B by angle θ in positive sense followed by rotating angle δ about new y_B (=y') axis
$x_{B,V}$, $y_{B,V}$, $z_{B,V}$	coordinates of body vortex in x_B, y_B, z_B coordinates
x_B	axial distance behind body nose
$x_{B,s}$	distance from body nose to body separation location
$x_{B,TLE}$	value of x_B at leading edge of tail fin root chord
$x_{B,TTE}$	value of x_B at trailing edge of tail fin root chord
$x_{B,WLE}$	value of x_B at leading edge of wing root chord
$x_{B,WTE}$	value of x_B at trailing edge of wing root chord
XST	axial distance parameter, equation (6)
XM, YM, ZM	coordinates of moment center in x_B, y_B, z_B coordinates; YM = 0
y_V, z_V	coordinates of right body vortex with y_V measured positive to right of plane of α_c and z_V measured in α_c plane normal to flow direction

2. GENERAL APPROACH

2.1 Body of Revolution with Cruciform Fins

The basic methods employed to represent an axisymmetric body with cruciform fins have been described in reference 1. The computer program of that reference is based on the wave equation associated with supersonic, linear flow theory. The program models axisymmetric bodies and the fins accounting for mutual interference by the inclusion of an interference panel shell around the body where fins are attached. This program served as the starting point for the determination of the aerodynamic characteristics at higher angles of attack by the inclusion of nonlinear features in the methods initially developed in reference 2. They include the full Bernoulli relationship for the pressure coefficient and the capability to account for specified or hand calculated vorticity shed from the body nose and the fins. In the computer program of reference 2, the body nose vortex strengths and positions for the case at hand were extracted from the experimental data presented in reference 4 and added to the program input.

The present wing-body program, designated DEMON2, incorporates the data for body nose vorticity as a function of axial distance from the nose if the body is circular in cross section. These data, used if the included angle of attack exceeds 4°, are tabulated in this report. The calculation of the vorticity shed from the edges of the fins is now performed by program DEMON2, as described in Appendices B and C. Results include the distribution of vorticity along the leading and side edges, which contribute to one or more concentrated vortices at the trailing edge on each side. A program designated VPATH2, based on slender-body theory, is used to track body nose vortices past the canard section, and to track body nose vortices and canard vortices past the afterbody and tail section for the case involving an axisymmetric body. The fins can have arbitrary deflection. This program serves as a companion to program DEMON2. The crossflow plane solutions are given in Appendix I. For cases involving axisymmetric bodies, program DEMON2 then computes, in a series of steps, the pressures acting on the body surface, fins and the part of the body covered by the interference shell including the effects of body and fin vortices where applicable. A detailed description of the procedure is given subsequently in section 5.1.

2.2 Elliptical Body with Monoplane Wing and Interdigitated Fins

For the purpose of handling a body with elliptical cross section, a separate program designated WDYBDY has been developed. This program serves as a companion to program DEMON2 and performs the body-alone modeling when the cross section of the body is elliptical. The method makes use of supersonic body source panels distributed on the surface of the body to account simultaneously for volume and angle of-attack effects. In addition, program DEMON2 has been generalized to treat an interference panel shell with elliptical cross section to which either a monoplane wing or interdigitated tail fins can be attached. The required geometrical transformations and extended flow tangency condition are described in Appendix E. For a body with elliptical cross section, the body nose vorticity characteristics are read in to program WDYBDY and are determined from a separate method since no data base is available as yet. A combined theoretical-empirical computer program for this purpose was developed for the spin-entry studies described in reference 5. This program was specialized to determine the strengths and positions of vortices shed from noses with elliptical cross section at supersonic conditions. For the sake of illustrating the use of the programs, an application of it is included in the second calculative example described later. The vortices are tracked by program VPATHL, based on slender-body theory, past the monoplane wing section and along the body with elliptical cross section up to the tail section if the length of the body is long enough.

For configurations involving bodies with elliptical cross section, program WDYBDY computes the pressures on the body surface up to the forward lifting surfaces (monoplane wing) and between the forward surfaces and tail surfaces (interdigitated tails) including effects of body and wing vortices where applicable. In the monoplane wing and interdigitated tail regions, program DEMON2 determines the pressures on the lifting surfaces and the part of the body covered by the interference panel shell including the effects of vortices where applicable.

By using the above mentioned programs in sequence it is possible to compute the pressure distributions and fin loadings acting on complete configurations by treating first the nose section, then the forward lifting surface section, followed by the afterbody and the tail section.

3. DETAILED APPROACH FOR BODIES OF REVOLUTION WITH CRUCIFORM FINS

In this section, the paneling method used to model lifting surfaces and the line singularity distributions used to model axisymmetric bodies will first be summarized. The method used to account for body-fin mutual interference is described. Features added to the boundary condition, to be shown below, include an account for fin thickness and arbitrary fin deflection. The separation vorticity data associated with axisymmetric body noses is tabulated and the pressure calculation method is described.

3.1 Modeling of Fins by Constant u-velocity Panels

Each fin of a cruciform fin-axisymmetric body combination is divided into trapezoidal area panels. The geometrical layout is accomplished by subroutine LAYOUT of program DEMON2. These panels are called constant u-velocity panels for supersonic flow and are located in the chordal planes of the lifting surfaces. When the full Bernoulli equation is used to calculate pressure, these panels are no longer constant pressure panels as referred to by Woodward et al. in reference 6. The solution for a given panel is generated by a superposition of the basic solutions for semi-infinite triangles with their apexes at the panel corners. The basic solution and superposition schemes, as implemented in subroutines VELO and VELNOR of program DEMON2, are described in great detail in sections 3.3.2 through 3.3.6 and Appendix II of reference 7. In addition, the effects of fin thickness are accounted for by the use of constant strength source panels located in the chordal planes of the fins. Their solutions are also obtained by a superposition scheme of semi-infinite triangles as described in section 3.3.4 and Appendix II of reference 7. In program DEMON2, the basic solution and superposition schemes associated with the constant strength source panels for fin thickness are programmed in subroutines VELOTH and THKVEL, respectively.

3.2 Modeling of Body of Revolution Alone

The potential flow model used to represent an axisymmetric body in supersonic flow is described in detail in section 3.2 and Appendix I of reference 7. Such a body can be represented by a distribution of line sources/sinks and line doublets along the body centerline to account for volume and angle of attack effects, respectively. The strengths of these singularities are determined from the flow tangency condition applied at points on the body surface using a marching procedure from the nose tip to body base. Subroutine BDYGEN of program DEMON2 is concerned with the layout and strength determination of the line singularities. It is possible that a portion of the body nose contour lies outside the Mach cone from its apex at the nose tip. This can occur for high Mach numbers. In this case, the present version of subroutine BDYGEN has been programmed to move the origins of the line singularities up towards the body nose. The result is to minimize the inherent error in the solution near the nose if the Mach cone from the nose tip intersects the body contour. The part of the nose contour outside the Mach cone is then replaced by a cone. This constitutes a limitation to the method. An illustration of this scheme will be discussed later in connection with the pressure distribution on an ogive-cylinder using the Bernoulli pressure expression.

3.3 Body Interference Shell for Fin-Body Interference

An interference shell is positioned around the body over the length covered by the fins to account for fin-body interference. Constant u-velocity panels are distributed on this shell by subroutine LAYOUT in addition to those on the fins. The panels on the interference shell and fins contain one control point each, which is located at the 95 percent chord containing the panel centroid. A typical distribution of constant u-velocity panels is shown in figure 1. The body and wing coordinate system, (x_B, y_B, z_B) and (x_W, y_W, z_W), respectively, are also shown. The axial location on the centerline of the origin of the latter is at the axial location of the leading edge of the fin root chords. Both coordinate systems can be the reference coordinate system. Fins in the $z_W = 0$ or $z_B = 0$ plane are called horizontal fins. Fins in the $y_W = 0$ or $y_B = 0$ plane are called vertical fins. Angle of pitch, α, and sideslip, β, are determined from the included angle of attack, α_c, and roll angle ϕ.*

*See equation (12)

3.4 Wing-Body Interference Solution

For the cruciform fin-axisymmetric body combination shown in figure 1, the strengths of the line singularities representing the body itself are solved for by subroutine BDYGEN in program DEMON2. Body on fin interference is accounted for as follows. The velocities normal to the fins at the control points induced by the body line singularities are computed by subroutine VELCAL in program DEMON2. On the horizontal fins these velocities are added to the free-stream component normal to the fin surface including the effect of fin deflection. On the vertical fins, the body induced normal velocity is added to the free-stream component normal to the vertical fin surface. These additions are performed in routine CRFWBD of program DEMON2. If external vortices are present, their effects are determined separately by program VPATH2 and added to the body induced velocities by an exchange of data sets between VPATH2 and DEMON2. The flow tangency condition applied to the control points on the horizontal fins is built up in routine CRFWBD of program DEMON2 as follows. Let the number of panels laid out over the cruciform fins and interference shell be NWBP and let NRP be the number of panels on the right horizontal fin only. Then, with ν as index for all the control points and n the summation index for all the constant u-velocity panels, the flow tangency condition for the right horizontal fin is given by

$$\sum_{n=1}^{NWBP} w_{W_{\nu,n}} = -\sin(\alpha + \delta_{H,R}) - w_{W_i,\nu} \quad , \quad \nu = 1,2,\ldots NRP \qquad (1)$$

where α is the angle of pitch and $\delta_{H,R}$ is the deflection of the right horizontal fin. The term on the left-hand side represents the summed velocity component (for unit V_∞) normal to the horizontal fin induced by all constant u-velocity panels on the fins and interference shell of the finned section under consideration. The method for calculating the terms on the left-hand side of equations (1) through (5) is given on page 6 of reference 1 or section 3.3.4 of reference 7. The first term on the right-hand side is due to the free-stream velocity, and the second term $w_{W_i,\nu}$ is induced by the body singularities and external vortices if present. Setting NHP equal to the number of constant u-velocity panels on both horizontal fins, the flow tangency on the left horizontal fin is expressed as

$$\sum_{n=1}^{NWBP} w_{W_{\nu,n}} = -\sin(\alpha + \delta_{H,L}) - w_{W_i,\nu} \quad , \quad \nu = NRP+1,\ldots NHP \qquad (2)$$

where $\delta_{H,L}$ is the deflection of the left horizontal fin. Let N3P be equal to the number of constant u-velocity panels on the upper vertical fin plus the number on the horizontal fins. The flow tangency condition applied at the control points of the upper vertical fin is written as follows:

$$\sum_{n=1}^{NWBP} v_{W_{\nu,n}} = \sin(\beta + \delta_{V,U}) - v_{W_i,\nu} \quad , \quad \nu = NHP+1,\ldots N3P \qquad (3)$$

Angle β is angle of sideslip and $\delta_{V,U}$ is the deflection of the upper vertical fin. The term on the left-hand side represents the summed velocity normal to the upper vertical fin induced by all constant u-velocity panels on the fins and interference shell. The first term on the right-hand side is due to the free-stream velocity, and the second term $v_{W_i,\nu}$ is induced by the body singularities and external vortices if present. The flow tangency applied at the control points of the lower vertical fin is

$$\sum_{n=1}^{NWBP} v_{W_{\nu,n}} = \sin(\beta + \delta_{V,D}) - v_{W_i,\nu} \quad , \quad \nu = N3P+1,\ldots NPANLS \qquad (4)$$

Here $\delta_{V,D}$ is the deflection of the lower vertical fin and NPANLS is the sum of the panels on the horizontal and vertical fins.

For cruciform fin-axisymmetric body combination the fins lie in mutually perpendicular planes of symmetry of the cylindrical body (at least for the fins at zero cant angle). Consequently, thickness effects of one fin cannot influence the loading on other fins but they can affect the panels on the interference shell. Therefore, if fin thickness is to be accounted for, the flow tangency condition applied at a control point on the interference shell is now stated as follows:

$$\sum_{n=1}^{NWBP} v_{N_{\nu,n}} = - v_{N_t,\nu} \quad , \quad \nu = NPANLS+1,\ldots NWBP \qquad (5)$$

In this instance, the term on the left-hand side is the summed velocity normal to the body interference panel with index ν induced by the constant u-velocity panels on the fins and the shell itself. The term on the right-hand side is the velocity normal to the ν^{th} body interference panel induced by all the source panels laid out over the fins to model thickness effects. In this way, fin on body interference is accounted for. Note that vortex induced velocity components are not included in the boundary condition associated with the interference shell, equation (5). The two-dimensional approach used to track vortices past bodies and body-fin combinations already insures that there is no flow through the body surface and fins due to the presence of external vortices. However, to satisfy the fin boundary condition in a three-dimensional sense, the loading on the fins due to the vortices is accounted for on the basis of tne panel method from the known vortex paths. Thus, the vortex paths from the leading edge of the cruciform canard on to the tail are first calculated by program VPATH2 on the basis of slender-body theory accounting for the geometry of the configuration. Then, for the axial location of each control point on the fins, subroutine VVELS of program VPATH2 also calculates the velocities at the fin control points induced by the external vortices and their images for the body alone. In this approach, the reaction of the fins to the effect of external velocities comes from two sources. First, the strengths of constant u-velocity are affected by the vortex induced effects in the boundary condition. Second, the pressures calculated subsequently by subroutine SPECPR of program DEMON2 at points on the fins contain all induced velocity components from the external vortices. Further discussion of fin pressures can be found at the end of this description. Pressures as calculated by subroutine BDYPR at the control points of the constant u-velocity panels on the body interference shell also include contributions from the external vortices and their images for the body alone as calculated by program VPATH2.

Equations (1) through (5) form a set of simultaneous equations from which the unknown constant u-velocity panel strengths can be solved. The number of unknown in the set of simultaneous equations is given by NWBP. The matrix solution is performed by subroutines LINEQS and SOLVE in program DEMON2. Constant u-velocity panel strengths are expressed in terms of the axial perturbation velocity component $\frac{1}{\pi}\frac{u^+}{V_\infty}$. It has a constant value for all points in the constant u-velocity panel.

3.5 Nose Vortex Characteristics

For configurations involving body noses with circular cross section, program DEMON2 is now equipped to determine body nose vortex characteristics up to the cruciform canard section from a data base built into subroutine BDYVTX. The data base is extracted from the compiled experimental data displayed in figure 5 of reference 4. The shed vorticity is represented by two concentrated symmetrical vortices whose strengths and positions in the cross flow plane are given as a function of axial distance from the nose. The separation distance, $x_{B,s}$, measured from the nose is obtained from either equation (5), reference 4, for sharp noses or equation (6), reference 4, for noses with cone semi-apex angles in excess of 30°.

The vorticity characteristics are to be determined at some axial distance from the nose, x_B. The axial location aft of the separation point is nondimensionalized by the body radius at the base of the nose designated RB in subroutine BDYPR. This subroutine calls subroutine BDYVTX and computes the pressure distributions on the body nose (and the portion of the body between the canard and tail fin regions). In subroutine BDYVTX, the nondimensionalized axial distance is multiplied by $\sin \alpha_c$, where α_c is the included angle of attack, and the result is named XPAR. This subroutine then proceeds to interpolate in a table containing a finite set of values for the axial distance parameter called XST.

$$\mathrm{XST} = \frac{x_B - x_{B,s}}{r_b} \sin \alpha_c \qquad (6)$$

Vortex strengths are designated GAMT and are nondimensionalized by the free-stream velocity V_∞ and the local body radius, a, which is a function of axial distance. As a function of the axial parameter XST, the table contains values for GAMT taken off the lower curve of figure 5(a) in reference 4.

$$\mathrm{GAMT} = \frac{\Gamma_B}{2\pi a(x_B) V_\infty \sin \alpha_c} \qquad (7)$$

This curve contains data for both supersonic and subsonic speeds. The coordinates in the cross flow plane are also divided by the local body radius with z_V aligned with the component of the free stream in the cross flow plane and y_V normal to it, positive to the right. The tables in subroutine BDYVTX contain y_V coordinates for both subsonic and supersonic flow conditions denoted YA1 and YA2, respectively. The latter is used here. Only one set is given for the z_V coordinate designated ZA1.

$$\left.\begin{aligned} YA2 &= \frac{y_V}{a(x_B)}\bigg|_{\text{supersonic}} \\ ZA1 &= \frac{z_V}{a(x_B)} \end{aligned}\right\} \tag{8}$$

Thus, for a given axial distance from the nose, x_B, ahead of the forward lifting surface region, the vortex strengths and positions are determined by interpolation from the table shown below.

XST	GAMT	YA2	ZA1
0	0.3	0.63	1.14
1.0	0.32	0.64	1.26
2.0	0.34	0.663	1.38
3.0	0.40	0.665	1.5
4.0	0.48	0.678	1.615
5.0	0.62	0.69	1.73
6.0	0.77	0.70	1.84
7.0	0.90	0.715	1.95
8.0	1.0	0.725	2.05
9.0	1.08	0.735	2.14
10.0	1.15	0.74	2.20

The coordinates y_V/a and z_V/a obtained from the above table by interpolation for given x_B are transformed into the body fixed coordinate system by a rotation through angle of roll ϕ. This process is performed in subroutine BDYPR and it is followed by a call to subroutine VRTVEL to calculate all velocity components induced by the separation vortices at points on the axisymmetric body at axial location x_B. These velocity components are then combined with the velocity components induced by the line sources/sinks and line doublets of the body of revolution itself for the purpose of determining the pressure distribution, as described below.

3.6 Pressure Distribution Calculations

The resultant velocity at a point on the body surface, including effects of free stream, is given by

$$\frac{V_R}{V_\infty} = 1 + \frac{2u}{V_\infty}\cos\alpha_c - \frac{2v}{V_\infty}\sin\alpha_c\sin\phi + \frac{2w}{V_\infty}\sin\alpha_c\cos\phi + \frac{u^2 + v^2 + w^2}{V_\infty^2} \tag{9}$$

where flow angle α_c is the included angle of attack and ϕ is the angle of roll. This result is obtained by applying the pitch-roll transformation shown in table 1-2 of reference 8 to the velocity components (u,v,w) aligned with the body coordinate system (x_B, y_B, z_B). The resultant velocity calculated in subroutine BDYPR using equation (9) is then substituted into the Bernoulli pressure-velocity relationship repeated here for convenience.

$$C_P = \frac{p - p_\infty}{q_\infty} = \frac{2}{\gamma M_\infty^2}\left\{\left[1 + \frac{\gamma-1}{2} M_\infty^2 \left(1 - \frac{V_R^2}{V_\infty^2}\right)\right]^{\frac{\gamma}{\gamma-1}} - 1\right\} \tag{10}$$

The pressure coefficient has the limiting value corresponding to vacuum pressure (p = 0) so that it is equal to

$$C_{P_{min}} = \frac{-2}{\gamma M_\infty^2} \tag{11}$$

The above pressure calculations at points on the surface of an axisymmetric body are performed by subroutine BDYPR of program DEMON2. For the parts of the body covered by the interference shell, the pressures are calculated by program BDYPR also in the same manner using ENTRY BDYAFT. The resultant velocity calculated by means of equation (9) then includes contributions from the constant u-velocity panels on the fins and interference shell in addition to the contributions from the body line singularities and external vortices when applicable. Pressures on the fin are also computed with the Bernoulli pressure equation (10). The velocity component contains contributions from the constant u-velocity panels distributed over the fins and interference shell, contributions from the body singularities and external vortices where applicable. Special care must be taken in the calculation of the discontinuous velocity components immediately above and below the control points of the constant u-velocity panels on the fins. In subroutine SPECPR of program DEMON2, they are related directly to the strength of the panel under consideration.

Some comparisons with measurements are given in the results comparisons, section 7, for the case of an ogive cylindrical body without body nose vorticity. These comparisons serve to test the body modeling method and the pressure expression used.

In determining the effect of the canard vortices on the pressure distribution, it is first necessary to establish the strength and position at the canard fin trailing edges. This is accomplished as described in Appendices B and C. The vortices are tracked back to the empennage using a vortex tracking program based on slender-body theory. The velocities included in this calculation are described in Appendix I.

4. DETAILED APPROACH FOR ELLIPTICAL BODY WITH MONOPLANE WING AND INTERDIGITATED CRUCIFORM TAIL

This section of the report gives a short description of the method using body source panels to represent a body with elliptical cross sections at combined angle of pitch and sideslip. Extensions to the flow tangency conditions are pointed out. The method used to include effects of specified body nose vorticity is described. The flow angles and the velocity components used in the pressure expression are given. Figure 2 shows a body source panel layout for a body with elliptical cross sections.

4.1 Modeling of Monoplane Wing, Interdigitated Tails and Elliptical Body by Body Source Panels

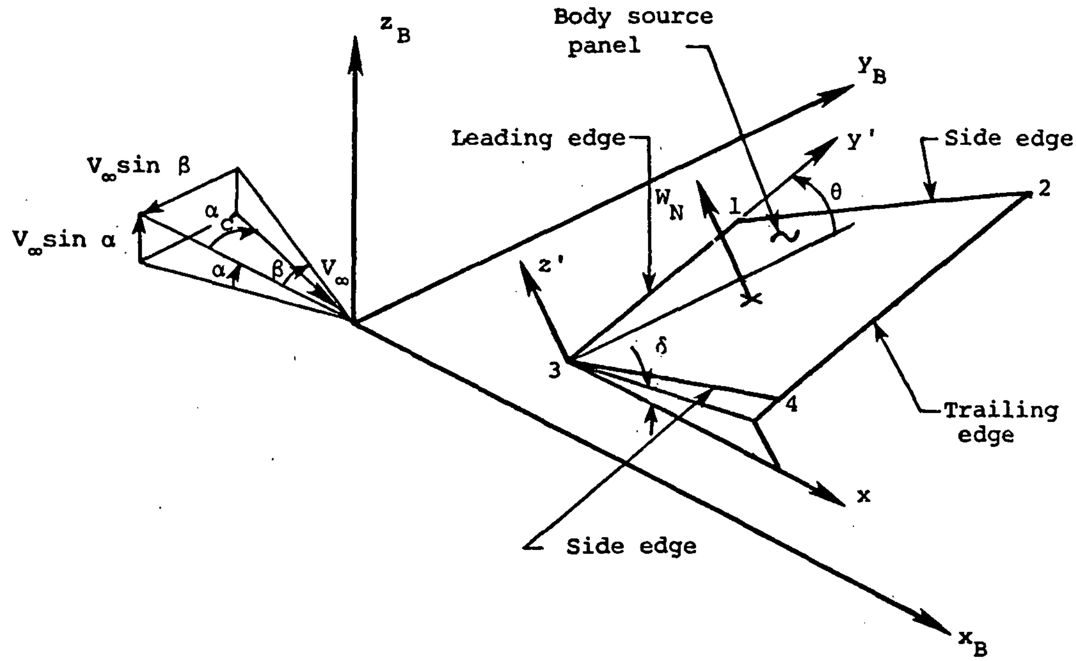
Basically, the layout of constant u-velocity panels on the monoplane wing or interdigitated tails is performed in the same way as for cruciform fins by subroutine LAYOUT of program DEMON2. For interdigitated tails, additional geometric transformations are required to express panel corner coordinates and induced velocities in the reference coordinate system which can be either the body (x_B, y_B, z_B) or wing (x_W, y_W, z_W) coordinate system shown in figure 1. These transformations are discussed in Appendix D. At the present time thickness effects are included only for the monoplane wing using planar source panels mentioned earlier in connection with cruciform fins. Program DEMON2 has been extended to allow for an interference shell with elliptical cross section. The additional analysis required with regard to the load calculation is given in Appendix G concerned with body interference panels on a shell with elliptical cross section. As far as the attitude of a given body interference panel is concerned, the angle between the panel trailing edge and the y_B or y_W axis is now calculated in accordance with the expressions for $\theta_{2,BIP}$ shown in figure 3. This angle is used in the transformation from the body interference panel coordinate system to the wing or body reference coordinate system (and vice versa) as performed by subroutine TRBIPW of program DEMON2.

The body itself with elliptical cross section is modeled by program WDYBDY using supersonic body source panels which can be inclined to the flow. A typical layout of body source panels on a body with elliptical cross section is shown in figure 2. The angle of inclination between a body source panel and the body centerline is limited to the semi-apex angle of the Mach cone associated with the free-stream Mach number. Thus, there is a limit to which body noses can be modeled by the body source panel method. The solution for such a panel is based on supersonic, linear theory as described in reference 9. As is the case for constant u-velocity panels, the influence of one body source panel (not to be mistaken for the planar source panel used to model fin thickness) is also obtained by summing the influences of the four panel corners. The basic expressions for perturbation velocity components are given on page 35 of the cited reference. Program WDYBDY consists of body modeling subroutines extracted from the computer program described in reference 10 and modified to account for combined angles of pitch and sideslip. The subroutines affected by this modification are SOLVE, PRESS, and FORMOM in program WDYBDY. The specific modifications will now be described.

Angle of pitch, α, and angle of sideslip, β, are related to the included angle of attack, α_c, and angle of roll, ϕ (positive right fin or wing down), in accordance with the pitch-roll sequence described in reference 8, Table 1-2. As a result, the pitch and sideslip angles are determined from the following expressions.

$$\left.\begin{aligned} \sin\alpha &= \sin\alpha_c \cos\phi \\ \sin\beta &= \sin\alpha_c \sin\phi \end{aligned}\right\} \qquad (12)$$

The orientation angles, δ and θ, associated with an inclined body source panel and the flow angles, α and β, are shown in the sketch below. Also indicated are the local coordinate systems x', y', z' associated with the source panel and the reference coordinate system x_B, y_B, z_B. The orientation angles δ and θ are shown in their positive sense if the panel corner numbering sequence is as indicated in the sketch. Axis x' is aligned with x_B.



In subroutine SOLVE of program WDYBDY, the contribution from the free stream to the flow tangency condition has been modified to include components due to pitch and sideslip. The component from the free stream normal to the body source panel inclined at angle δ to the x',y' plane and inclined to the $z_B = 0$ plane at angle θ is expressed below. This quantity is designated W_N/V_∞ and is programmed as NB(I) in subroutine SOLVE.

$$\frac{W_N}{V_\infty} = \sin\alpha \cos\theta \cos\delta + \sin\beta \sin\theta \cos\delta - \cos\alpha_c \sin\delta \qquad (13)$$

With the contribution from the free stream given by the above equation, the flow tangency condition is applied at the control points (centroids) of the body source panels. The result is a set of simultaneous equations from which the panel strengths are obtained. The matrix solution is an iterative one if the number of source panels is in excess of 60.

4.2 Pressures, Forces, and Moments on Body with Elliptical Cross Section

The pressure coefficient is computed at the body source panel control points by subroutine PRESS in program WDYBDY using the Bernoulli pressure-velocity relationship, equation (10). In subroutine PRESS the resultant velocity V_R was originally determined from the velocity components in the wind-axis system for the unrolled case. Using the transformations indicated in Table 1-2 of reference 8 for the combined pitch and roll case, the components in the wind-axis system $(\bar{u},\bar{v},\bar{w})$ are related to the components (u,v,w) aligned with the body axis system (x_B,y_B,z_B) as follows.

$$
\left.
\begin{aligned}
\frac{\bar{u}}{V_\infty} &= \frac{u}{V_\infty}\cos\alpha_c - \frac{v}{V_\infty}\sin\beta + \frac{w}{V_\infty}\sin\alpha \\
\frac{\bar{v}}{V_\infty} &= \frac{v}{V_\infty}\cos\phi + \frac{w}{V_\infty}\sin\phi \\
\frac{\bar{w}}{V_\infty} &= -\frac{u}{V_\infty}\sin\alpha_c - \frac{v}{V_\infty}\cos\alpha_c\sin\phi + \frac{w}{V_\infty}\cos\alpha_c\cos\phi \\
\frac{V_R^2}{V_\infty^2} &= \left(\frac{\bar{u}}{V_\infty}\right)^2 + \left(\frac{\bar{v}}{V_\infty}\right)^2 + \left(\frac{\bar{w}}{V_\infty}\right)^2
\end{aligned}
\right\} \quad (14)
$$

The last quantity is denoted Q2 in subroutine PRESS of program WDYBDY. The angles associated with the trigonometric functions are described in connection with equation (12).

In order to add the capability of including effects from specified body nose vorticity in the body pressure calculation, program WDYBDY is equipped with additional subroutines. Subroutine READVX reads in an array of axial locations measured from the body nose, ELBDVT reads arrays containing the lateral coordinates and strengths of the vortices. For the axial location of a given control point in a body source panel, these subroutines interpolate for the coordinates in the cross flow plane and strengths of the vortices. Subroutine VVELS then proceeds to compute the velocity components induced by the set of external vortices and their images inside of an elliptical cross section at the control point. This application of slender-body theory is a degenerate form of one of the crossflow plane solutions described in Appendix I in connection with vortex path calculations. The flow tangency condition at the body surface is therefore satisfied and the body source panel strengths are not affected. The vortex induced velocities are calculated in the body reference coordinate system and added to the v and w velocity components in equation (14). In connection with the application of slender-body theory to elliptical cross sections, a special procedure is followed to avoid numerical problems leading to unrealistic values for the velocity components at the body source panel control points. Essentially, the control points are moved just outside the actual body circumference as described in detail in Appendix H.

Once the pressures on the body are known, subroutine FORMOM, as applied to the body modeling program WDYBDY, computes the overall forces and moments acting on a body with elliptical cross section. This subroutine was extended to include calculating the side force and yawing moment for the pitched and rolled case. First, a normal-force "coefficient" is defined* for one body source panel as follows.

$$C_N\Big|_{panel} = -\,C_P\ \text{Area}\Big|_{panel} \tag{15}$$

By first resolving through the panel inclination angle δ and then through the azimuthal orientation angle θ, the forces on the panel expressed in the body coordinate system (x_B, y_B, z_B) indicated in figures 1 and 2 are given by

$$\left.\begin{aligned} C_{x_B}\Big|_{panel} &= -\,C_N\Big|_{panel} \sin\delta \\ C_{y_B}\Big|_{panel} &= -\,C_N\Big|_{panel} \cos\delta\,\sin\theta \\ C_{z_B}\Big|_{panel} &= C_N\Big|_{panel} \cos\delta\,\cos\theta \end{aligned}\right\} \tag{16}$$

Angles δ and θ are shown in the sketch discussed above.

The contributions from one body source panel to the moments are determined as follows. The pitching and yawing moments are first calculated in terms of the body coordinate system. In this way, the pitching-moment vector is normal to the $y_B = 0$ plane and the yawing-moment vector

*Normal force per unit dynamic pressure.

is normal to the $z_B = 0$ plane. Rolling-moment vector lies along the x_B axis. For one body source panel, the contribution to the pitching-moment coefficient in the body coordinate system is stated below.

$$C_m\Big|_{panel} = - C_{z_B}\Big|_{panel}(x_{c,B} - XM) + C_{x_B}\Big|_{panel}(z_{c,B} - ZM) \qquad (17a)$$

nose up positive

The contribution to yawing moment in the body coordinate system is given by

$$C_n\Big|_{panel} = - C_{y_B}\Big|_{panel}(x_{c,B} - XM) + C_{x_B}\Big|_{panel} y_{c,B}\ , \qquad (17b)$$

nose to right positive

and the contribution to rolling moment in the body coordinate system is written as

$$C_\ell\Big|_{panel} = - C_{z_B}\Big|_{panel} y_{c,B} + C_{y_B}\Big|_{panel}(z_{c,B} - ZM)\ , \qquad (17c)$$

right fin down positive

In the above equations, $(x_{c,B}, y_{c,B}, z_{c,B})$ are the coordinates of the centroid or control point of the body source panel. The moment center is given by (XM, 0, ZM) in the body coordinate system. In subroutine FORMOM, the quantities defined by equations (16) and (17) are designated DCXB, DCYB, DCZB and DCMB, DCNYAW, DCLROL, respectively. The contributions to the forces from all the panels are then added and divided by a reference area designated REFA. The contributions to the moments are also added and divided by reference area REFA and reference length REFD.

For the pitched and rolled case, an additional transformation is performed in subroutine FORMOM to finally determine the forces and moments in the wind-axis system. Thus, let $C_z\big|_{wind\ axis}$ be in the plane formed by the body centerline and the free-stream velocity vector and lie in the direction normal to that vector. This quality is in fact the lift in coefficient form acting on the body and it is obtained by applying the body to wind axis transformation indicated on page 12 of reference 8.

$$C_L = C_z\Big|_{\text{wind axis}} = -C_{x_B} \sin \alpha_c - C_{y_B} \cos \alpha_c \sin \phi + C_{z_B} \cos \alpha_c \cos \phi \tag{18a}$$

Let $C_Y\big|_{\text{wind axis}}$ be the force normal to the plane formed by the body centerline and the free-stream vector, positive to the right.

$$C_Y\Big|_{\text{wind axis}} = C_{z_B} \sin \phi + C_{y_B} \cos \phi \tag{18b}$$

The axial force in the wind axis system, $C_X\big|_{\text{wind axis}}$, lies along the free-stream vector. It equals the drag-force coefficient C_D.

$$C_D = C_x\Big|_{\text{wind axis}} = C_{x_B} \cos \alpha_c - C_{y_B} \sin \alpha_c \sin \phi + C_{z_B} \sin \alpha_c \cos \phi \tag{18c}$$

In the wind axis system, the pitching-moment vector is normal to the plane formed by the free-stream vector and the body centerline, positive nose up. The pitch-roll transformation is applied again to the moments in the body axis system.

$$C_m\Big|_{\text{wind axis}} = C_m\Big|_{\text{body axis}} \cos \phi - C_n\Big|_{\text{body axis}} \sin \phi \tag{19a}$$

The yawing-moment vector in the wind axis system lies in the direction of the lift force, positive nose right.

$$C_n\Big|_{\text{wind axis}} = - C_\ell \sin \alpha_c + C_m\Big|_{\text{body axis}} \cos \alpha_c \sin \phi + C_n\Big|_{\text{body axis}} \cos \alpha_c \cos \phi \tag{19b}$$

In equations (18) and (19), angles α_c, ϕ, α and β are discussed above in connection with equation (12). They are designated ALPHAC, PHIR, ALPHA and BETA, respectively, in subroutines FORMOM, SOLVE and PRESS of program WDYBDY.

4.3 Wing-Body and Tail-Body Interference

Once the body with elliptical cross section is modeled by program WDYBDY for given included angle of attack, α_c, angle of roll, ϕ, and Mach number, the velocity components induced by the body source panels with known strengths are computed at the control points on the monoplane wing or interdigitated tail fins by an added subroutine BDYVEL of program WDYBDY. In this way, body to wing or fin interference is accounted for. This is accomplished by interchanging data sets between programs WDYBDY and DEMON2. Note that for axisymmetric bodies, program DEMON2 performs both the body modeling and fin modeling and no such data set exchange is required.

For the monoplane wing attached to the interference shell, the flow tangency condition for the right wing is given by equation (1). If the configuration is rolled in addition to pitched, the flow tangency condition must also be set up for the left wing, equation (2). The flow tangency condition applied at the control points of the constant u-velocity panels in the interference shell with elliptical cross section is given by equation (5). This boundary condition accounts for wing or fin on body interference. The strengths of the constant u-velocity panels distributed over the monoplane wing and the interference shell with elliptical cross section are then solved from the set of simultaneous equations generated by the flow tangency condition. Effects of external vorticity can be included in the wing boundary condition by exchanging data sets between programs DEMON2 and VPATHL. The latter program determines the paths of the body nose vortices as they pass through the monoplane wing section up to the tail section. It also computes velocity components induced at the control points of the constant u-velocity panels on the monoplane wing by the external (body nose) vortices in the presence of the body only. In this way the monoplane wing is influenced by the external vorticity in the boundary condition and in the calculation of pressures acting on the wing as performed by subroutine SPECPR in program DEMON2. The reason for this procedure is increased accuracy as mentioned in the previous section 3.4 concerned with cruciform fins on an axisymmetric body.

5. PROCEDURE FOR APPLICATION OF PROGRAMS TO COMPLETE CONFIGURATIONS

5.1 Circular Body with Cruciform Canard and Tail Fins

The following is a description of the step-wise use of programs DEMON2 and VPATH2 for handling a complete configuration with a body of circular cross section. The manner in which the programs are used sequentially and the exchange of data sets are indicated. The first three steps are concerned with the part of the configuration from the body nose to the trailing edge of the canard section. The remaining steps deal with the body aft of the canard and with the cruciform tail-fins. Finally, the procedure required to assemble pressure distributions acting on the entire configuration is given. The steps at which fin forces and moments are calculated are also indicated.

5.1.1 Sequential use of programs

Step 1(a). Run lifting-surface program DEMON2, with index NCPOUT set equal to 2 in namelist INPUT. This step generates the coordinates of the control points associated with the constant u-velocity panels distributed on the fins of the cruciform-canard and the body-interference shell. The number of control points and the sets of coordinates are stored in a data set designated TAPE4 = CPTS1. There are NWBP sets of coordinates where NWBP is the number of control points on the canard fins and the interference shell. This shell has constant circular cross-sectional area and covers the body from the leading-edge to the trailing-edge of the canard section. This step can be combined with step 1(b) discussed next by setting NCPOUT equal to 1 instead of 2.

Step 1(b). Consider the canard fins mounted on the body. The body is modeled from its nose to the trailing edge of the canard fin as a minimum. Run lifting-surface program DEMON2 with index NCPOUT set equal to zero in namelist INPUT. This step can be combined with step 1(a) by setting NCPOUT = 1. If the latter value is used, the program not only generates the data set containing the control point characteristics, CPTS1, but will also proceed to compute the pressure distributions on the body nose up to the canard section. If the included angle of attack is sufficiently high, the effects of body nose vorticity will be accounted for in the body pressures. In addition, the strengths of the constant u-velocity panels and subsequently the pressure distributions and loadings acting on the canard fins and interference shell are calculated without the effects of body nose vorticity. The output includes information concerning fin leading- and side-edge separation vorticity.

Step 2. Vortex path program VPATH2 is now employed to track the body nose vortices over the canard section. Input includes the data set designated CPTS1 containing the number and sets of coordinates of the control points on the cruciform canard fins and interference shell. This data set was generated in either step 1(a) or 1(b). In the input to program VPATH2, indices NCPIN and NVLOUT are set equal to 1 for this run. The former causes data set CPTS1 to be read in and the latter generates a data set designated VELOS1. The input to this program also includes the strengths and coordinates in the crossflow plane of the body nose vortices at the axial station corresponding to the start or leading edge of the canard section. These vortices are tracked back to the end or trailing edge of the canard section. Effects of fin edge vorticity (kept stationary) can be included in the determination of the paths of the body nose vortices. Fin leading- and side-edge vortex strengths (if comparable in magnitude to the body nose vortices) and locations are read-in by the program separately from the input associated with the vortices whose paths and effects are to be calculated.

After the vortex paths have been calculated, program VPATH2 calculates the perturbation velocities induced by the body nose vortices at the control points of the canard fins and interference shell. The velocity components are stored in data set TAPE7 = VELOS1 mentioned earlier. In this velocity calculation, the effects of the vortices are calculated in the presence of the body only, or in other words as if the canard fins are not present.

Step 3. Program DEMON2 is run again with NVLIN = 1 and NCPOUT = 0 in namelist INPUT. The value of the first index tells the program to read in velocity components induced by the body nose vortices at the control points on the canard fins and the interference shell as the vortices pass by the canard section. This information was generated in step 2 by program VPATH2 and stored in data set TAPE7 = VELOS1. The strengths of the constant u-velocity panels are then recalculated including the effects of the external body nose vortices. As a result of this calculation, the pressure distributions, forces and moments on the canard fins and pressures on the body aft of the leading edge of the canard root chord include effects induced by the body nose vortices.

At this stage, the output also contains specifications for the concentrated vortices associated with the fin trailing edges. Specifications calculated on the basis of Bernoulli-type loading pressures will be used in a later step. Furthermore, the distributions of fin leading- and side-edge vorticity calculated on the basis of linear (u/V_∞ type loading pressure) theory will be considered in the calculations that follow.

Step 4. Program DEMON2 is applied to treat the tail fin section mounted on the body. The body is modeled from the nose to its base. In this step, effects of external vortices are not accounted for. Index NCPOUT = 1, NVLIN = 0 and ITAIL = 1 in namelist INPUT for this run. In addition, quantity XSTART must be set equal to the axial location of the trailing edge of the canard section.

The first index causes the program to generate a data set designated CPTS2 which contains the number and sets of coordinates associated with control points on the tail fins and interference shell. Additionally, this data set contains the sets of coordinates specifying points on the body surface between the canard and tail section at which pressures will be calculated. At this stage, the calculated pressures on the body do not include effects of external vorticity. The tail fin loadings do not include effects of body nose and canard fin vorticity so far.

Step 5. The vortex path program VPATH2 is now used to chase external vortices from the canard section, along the aft body, past the tail section, to the body base. Index NCPIN = 1 and NVLOUT = 1 for this run. The value given to the first index causes the program to read in data set CPTS2 containing control and body pressure points. Velocity components induced by the external vortices are calculated at the points whose coordinates are in data set CPTS2. The value given to the second index results in the generation of data set TAPE7 = VELOS2 which contains the induced velocity components. The strengths and positions of the vortices at the trailing edge of the canard section as required by the input to program VPATH2 for this run include the following:

1. Body nose vortices whose characteristics are available at the trailing edge of the canard section as a result of step 2 calculated by program VPATH2.

2. Concentrated vortices emanating from the trailing edges of the canard fins. Strengths and locations of these vortices are available from the results (based on Bernoulli pressures) generated by program DEMON2 at the end of step 3.

3. Fin leading- and side-edge separation vortices, if their strengths are comparable to the strengths of the vortices of 1 and 2. Their strengths and spanwise positions (based on linear pressures) at the fin trailing edge are also calculated by and appear in the output of program DEMON2. The user may input a distance off the fin plane equal to the product of the root chord and the tangent of half the angle of attack seen by the fin in question.

After the paths of the above vortices are calculated, program VPATH2 proceeds to compute their effects at points on the aft body and on the tail section as mentioned above. In this process, the velocity components induced by the external vortices are calculated in the presence of the body only, or in other words as if the tail fins are not present.

Step 6. Finally, program DEMON2 is applied again to the tail fins on the body. Index NCPOUT = 0, NVLIN = 1 and ITAIL = 1. The program reads in data set TAPE7 = VELOS2 which contains vortex effects calculated in the previous step at points on the aft body and the tail section including the fins.

The strengths of the constant u-velocity panels are recalculated including the effects of body- and canard-fin vortices. As a result of this calculation, the pressure distributions, forces and moments acting on the tail fins and the pressure distributions on the body from the canard section to the body base are affected by the body and canard fin vortices.

5.1.2 Assembly of pressure, force and moment data

The results obtained in the stepwise manner described above allow for the determination of the pressure distributions on the body and forces and moments acting on the fins as follows.

Nose section: $0 < x_B < x_{B,WLE}$

At the end of step 1, the output of program DEMON2 includes circumferential pressure distributions at a finite number of axial stations from the nose tip to the leading edge of the canard section. From this information, meridional pressure distributions can also be obtained. Effects of body nose vorticity are accounted for in the velocity components used to compute Bernoulli pressures.

Canard section: $x_{B,WLE} < x_B < x_{B,WTE}$

Pressure distributions on the body aft of the leading edge of the fin root chords (up to the trailing edge) and on the fins are calculated by program DEMON2 in step 3. The results include effects of body nose vorticity. Normal forces and moments acting on the fins including the influence of body nose vorticity are also calculated and output by the program (refer to quantities under Bernoulli-type loading pressures). Any augmentation to the fin normal force due to fin leading- and side-edge separation can be determined from the following hand calculation using the quantities printed under the U/VINF (linear) type loading pressure. Consider the right horizontal fin (the other fins are treated the same way).

$$\left.\begin{aligned} & C_N\Big|_{LE} + C_N\Big|_{SE} = K_{LE}C_S\Big|_{LE} + K_{SE}C_S\Big|_{SE} \quad \text{(Polhamus' Analogy)} \\ & \text{If } K_{LE} \text{ and } K_{SE} \text{ are not input, then the following} \\ & \text{values are used in obtaining vortex strengths:} \\ & K_{LE} \cong 0.5;\ K_{SE} \cong 0.5 \text{ (default value)} \\ & C_S\Big|_{LE} = [(SUMFX)^2 + (SUMFY1 + SUMFY2)^2]^{1/2} \\ & C_S\Big|_{SE} = SUMFT2 \end{aligned}\right\} \qquad (20)$$

In the above SUMFX is the sum of all the forces acting upstream in the plane of the fin. For example, if NRP equals the number of constant u-velocity panels on the right horizontal fin

$$SUMFX\Big|_{\text{Right hor. fin}} = \sum_{n=1}^{NRP} \frac{\Delta F_{x,n}}{q} \qquad (21)$$

The axial in-plane force ΔF_x for one panel is shown in the second sketch of Appendix C. In-plane side force ΔF_{y_1} is also indicated and

$$SUMFY1 = \sum_{n=1}^{NRP} \frac{\Delta F_{y_{1,n}}}{q} \qquad (22)$$

The in-plane side force ΔF_{y_2} acting at the outboard aft corner is also shown in the second sketch of Appendix C. For all the panels on the fin except those at the tip chord

$$SUMFY2 = \sum_{n=1}^{NRP-NCW} \frac{\Delta F_{y_{2,n}}}{q} \qquad (23)$$

where NCW is the number of panels along the chord. Then by adding the contributions from the panels at the tip

$$\text{SUMFT2} = \sum_{n=\text{NRP}-\text{NCW}+1}^{\text{NRP}} \frac{\Delta F_{Y_2,n}}{q} \tag{24}$$

Section behind canard section: $x_{B,WTE} < x_B < x_{B,TTE}$

Pressure distributions on the aft body from the canard section up to the tail section are calculated in step 6 using program DEMON2. From the leading edge of the tail section to the trailing edge (assumed to be at the same axial location as the body base), the pressure distributions on the body appear under the heading AFT OF LEADING EDGE OF FIN ROOT CHORDS . Normal forces and moments acting on the tail fins including influence of body nose and canard vorticity are also calculated and printed by the program (refer to quantities under Bernoulli-type loading pressure). Any augmentation to the fin normal force due to fin leading- and side-edge separation can be determined from the hand calculation discussed earlier in connection with the canard fins, equations (20) through (24).

5.2 Elliptic Cross Section Body-Monoplane Wing-Interdigitated Tail Fins

The following is a description of the stepwise use of programs DEMON2, WDYBDY and VPATHL for handling a complete configuration with a body of elliptical cross section. The manner in which the programs are used sequentially and the exchange of data sets are indicated. The first five steps are concerned with the part of the configuration from the body nose to the trailing edge of the monoplane wing. The remaining steps deal with the body aft of the monoplane wing section and with the tail fins. Finally, the procedure required to assemble pressure distributions and overall forces and moments acting on the entire configuration is indicated.

5.2.1 Sequential use of program

Step 1. Run lifting-surface program DEMON2 with index NCPOUT = 2 in namelist INPUT. This run generates the coordinates of the control points associated with the constant u-velocity panels distributed on the monoplane-wing and the body-interference shell. The number of control points and the sets of coordinates are stored in a data-set designated TAPE4 = WCPTS. There are NWBP coordinates where NWBP equals the number of control points on the monoplane wing and the interference shell. This shell has constant elliptical cross section and covers the body from the leading edge to the trailing edge of the monoplane wing.

Step 2. Run body source panel program WDYBDY for the elliptical body alone with index NCWPT = NWBP in the input. This causes the data set containing control point coordinates designated TAPE4 = WCPTS to be read in. The body length should extend at least up to the trailing edge of the monoplane wing if the trailing edge is supersonic. If this edge is subsonic, the body length should extend past the monoplane wing section in order to account fully for body-wing interference. This program can also read in forebody separation vorticity characteristics calculated by a separate program mentioned in section 2 entitled GENERAL APPROACH. Results of this run include pressure distributions along body meridians up to the wing section including effects of body nose vorticity if applicable. In addition, perturbation velocities induced by body source panels alone at the specified control points are calculated. These velocities are stored in another data set designated TAPE4 = WVELS and passed to program DEMON2.

Step 3. Program DEMON2 is run again for the monoplane wing/elliptical interference shell with NCPOUT = 0 and NVLIN = 0 in the namelist INPUT. The program proceeds to calculate the constant u-velocity panel strengths including the effects induced by the body source panels. Output includes the strength and lateral positions of the leading- and side-edge vorticity associated with the monoplane wing as a function of axial location. So far, effects of body nose vortices have not been included.

Step 4. Run program VPATHL with indices NVLOUT = 1 and NCPIN = 1 in the input. It is applied to the monoplane wing/elliptical cross section body. The axial starting point is at the leading edge of the monoplane wing rootchord. Vortices to be tracked to the trailing edge are the body nose vortices whose strengths and positions are known at the leading edge of the monoplane wing root chord from results obtained with a separate program. The effects of wing leading- and side-edge vorticity (kept stationary) can be included in the calculation of the paths of the body nose vortices. The values given to the indices NCP and NCPIN causes program VPATHL to read in data set TAPE4 = WCPTS containing coordinates of the control points distributed on the monoplane wing and interference shell. After the body nose vortex paths have been calculated, perturbation velocities induced by the body nose vortices at the control points are computed and stored in data set TAPE7 = VRTVEL. In this velocity calculation, the effects of the vortices are calculated in the presence of the elliptical body only.

Step 5. Use program DEMON2 again with indices NVLIN = 1 and NCPOUT = 0 in the namelist INPUT. The value of the first index tells the program to read in velocities induced by the body nose vortices at the control points on the wing and interference shell as the vortices pass by the wing section. This information is stored in data set TAPE7 = VRTVEL. The strengths of the constant u-velocity panels are then recalculated including the effects of the external body nose vortices, and the body itself. The output includes pressure distributions on the monoplane wing and the length of body spanned by the wing section accounting for all vortices. In addition, strengths and positions of the trailing-edge vorticity of the monoplane wing are calculated from the spanwise load distributions. At this stage, the configuration has been treated from the body nose up to the trailing edge of the monoplane wing section. Strengths and locations of the body nose vortices, wing leading- and side-edge vortices and wing trailing-edge vortices are now known at the end of the wing section.

Step 6. If the tail section is located aft of the wing section by some length of body, this and the following step must be taken in order to track body nose and monoplane wing vorticity along the body up to the tail fin section. Program WDYBDY is run for the elliptic body only to generate coordinates of control points associated with the source panels laid out from the wing section to the tail section. These coordinates are stored in another data set designated TAPE4 = BCPTS, which is passed to program VPATHL.

Step 7. Program VPATHL is applied again to the elliptical body alone from the wing section to the tail section. If there is no body length between the wing rootchord trailing-edge and the tail fin rootchord leading-edge, this step is omitted. Vortices to be tracked over this length along the body include the body vortices, wing leading- and side-edge vortices and the wing trailing-edge vortices. Strengths and positions of these vortices are known at the monoplane wing trailing-edge location (see steps 4 and 5). Once the vortex paths have been determined, program VPATHL calculates the velocities induced by the vortices at the control points on the body passed through by means of data set TAPE4 = BCPTS generated by step 6. These velocities are to be passed back to program WDYBDY using data set designated TAPE7 = VRTVEB (step 9).

Step 8. Program DEMON2 is applied to the interdigitated tails to generate the coordinates of the NWBP control points distributed on the fins and the interference shell. Index NCPOUT is set equal to 2 in namelist INPUT and the coordinates are stored in a data set designated TAPE4 = TCPTS. This step is essentially a repeat of step 1 applied to the tail fin in this instance.

Step 9. The body program WDYBDY is applied to the entire body length of the configuration. Index NCWPT is set equal to NWBP, the number of control points on the tail fin and interference shell. As in step 2, a data set designated TAPE4 = TCPTS containing control points is read in. Velocities induced by the body source panels at the control points are calculated by program WDYBDY. They are stored in a data set designated TAPE4 = TVELS to be passed back to program DEMON2. In addition, by setting index NVLIN = 1 in the input to program WDYBDY, data set TAPE4 = VRTVEB generated in step 7 is read in. It contains velocities induced by external body and wing vortices. Their effects are included in the calculation of pressure distributions on the body from the wing section trailing edge to the leading edge of the tail fins. If there is no body length between these two stations, no such pressure distributions are calculated.

Step 10. In this final step, program DEMON2 is applied to the interdigitated tail fins with NCPOUT set equal to zero. This index signals the program to read in the body source panel induced velocities stored on data set TAPE4 = TVELS. For any case involving interdigitated fins, set NDRAG equal to zero. Strengths and positions of forebody vorticity, wing leading-, side- and trailing-edge vorticity are known at the leading edge of the tail section as a result of step 7, or 5 if there is no body length separating the wing and tail sections. Their influences are calculated at the tail fin control points assuming that the vortex paths are not disturbed by the presence of the fin surfaces. Pressure distributions are calculated on the fins and the part of the body spanned by the tailfin section. In addition, forces and moments acting on the fins are computed.

5.2.2 Assembly of pressure, force and moment data

The results obtained in the stepwise manner described above allow for the determination of the pressure distributions and overall forces and moments acting on the entire configuration by adding those calculated for the separate sections as follows.

Nose section: $0 < x_B < x_{B,WLE}$

Pressure distributions along body meridians, normal- and side-force, pitching- and yawing-moment contributions are calculated by program WDYBDY up to the leading-edge of the monoplane wing root chord. This is accomplished by step 2. Forces and moments are referred to the body-axis system with x_B directed back along the centerline, y_B to the right along the horizontal semi-axis viewing forward and z_B upwards along the vertical semi-axis for an elliptical body. In this way, the normal force C_z points along the positive z_B direction and side force C_y

in the positive y_B direction. Pitching moment is measured in the $y_B = 0$ plane. If the pitching moment acts to bring the nose up in this plane, the sense of this moment is positive. Yawing moment is measured in the $z_B = 0$ plane. If this moment acts to move the nose into the positive y_B direction, the sense of this moment is positive.

Canard section: $x_{B,WLE} < x_B < x_{B,WTE}$

Pressure distributions along body meridians are calculated by program DEMON2 over this body section in step 5. Normal- and side-force, pitching- and yawing-moment contributions from this body section* and the monoplane wing are also computed as a result of step 5.

Section behind canard section up to tail fins (if applicable): $x_{B,WTE} < x_B < x_{B,TLE}$

Over this length of body, the pressure distributions along body meridians are calculated by program WDYBDY as part of step 9. Normal- and side-force, pitching- and yawing-moment contributions are also computed. If there is no body length, $x_{B,WTE} - x_{B,TLE} \leq 0$, this part of the procedure is not applicable.

Tail section: $x_{B,TLE} < x_B < x_{B,TTE}$

Over this last body section, pressure distributions along body meridians are calculated by program DEMON2 in step 10. In addition, contributions to the normal- and side-force, pitching- and yawing-moment from this body section* and the tail fins are also calculated as part of step 10.

In general it is advantageous to let the number of source panels on the body circumference read into program WDYBDY match the number of circumferential constant u-velocity specified in namelist $INPUT of program DEMON1. In this way, the meridians on which pressures are computed are essentially the same. Reference areas and lengths must be the same in the inputs to programs WDYBDY and DEMON2. Force and moment coefficients calculated for the individual sections of the entire configuration can then be added to obtain overall forces and moments.

---

*Note that force and moment coefficients associated with the interference shell as calculated by program DEMON2 are only representative of lift carryover from the lifting surfaces to the body; refer to Appendix J.

6. CALCULATIVE EXAMPLES

In this section, two sample cases will be described. The first concerns a configuration designated $B_1W_4T_4$ associated with UPWT Project 1126, for which unpublished data was made available by NASA/Langley. This model consists of a cruciform canard and a cruciform tail attached to a body with circular cross section. The second case involves a wind tunnel model consisting of a monoplane wing and interdigitated tail section mounted on a body with elliptical cross section described in reference 11. These models are used in the sample cases to illustrate the use of the computer program described in this report.

For both cases, first the procedures used to determine the effects of body nose vorticity on the forebody pressures are indicated. Second, canard or monoplane loadings are determined including effects of the body nose vorticity. Third, the calculated canard edge vortices and the body nose vortices are tracked back through the tail section for the first sample case. Finally, the tail fin loadings are calculated including effects of all vortices. Special care must be taken in the positioning of the interference shell around a body with elliptical cross section as will be discussed below.

References will be made to the steps listed earlier in section 5. The method used to hand calculate the augmentation to normal force due to wing edge vorticity is indicated in section 6.2.3.

6.1 Sample Case 1: Axisymmetric Body-Cruciform Canard-Cruciform Tail Fins

The configuration of a model including a body with circular cross section and an ogive nose is shown in figure 4. The cruciform canard and tail fins are identical and details of the bevelled sections are indicated. Programs DEMON2 and VPATH2 are used to treat this configuration rolled 45° and at included angle of attack of 14.216°. Under these conditions the angle of pitch and sideslip are both equal to 10°. The Mach number is 1.70. Note that there will be no symmetry with respect to the wing-axis system x_W, y_W, z_W in terms of aerodynamic loading. Thus, all fins must be modeled. However, there will be symmetry in loading with respect to the direction of the free-stream component in the crossflow plane. In other words, the configuration is in the X-position relative to that direction. This condition serves as a check on the programs. For example, the loads on the upper vertical and left horizontal fins, indicated in figure 4, must be equal. Likewise, the vortex paths must be symmetrically positioned relative to the free-stream velocity component in the crossflow plane.

6.1.1 Geometry and singularity layout

The following geometrical specifications and singularity distributions will be used for the axisymmetric body and fins. The specified numbers of singularities along the body centerline and on the fins may not be sufficient for precise calculated results but serve to generate this sample case. Refer to figure 4 for geometrical details.

Namelist $BODY in subroutine BDYGEN of program DEMON2 includes specifications for the body:

number of line sources/sinks and line doublets, NXBODY = 39
nose length, LNOSE = 7.8
body length, LBODY = 39.0

The body radius for the cylindrical section, RB, is specified in the following.

Namelist $INPUT in main routine CRFWBD of program DEMON2 includes specifications for either the canard or the tail fins and the corresponding body interference shell.

rootchord, CRP = CRPV = 3.6
exposed semi-span, B2 = B2V = 2.34
leading-edge sweep, SWLEP = SWLEV = 30.0°
trailing-edge sweep, SWTEP = SWTEV = 0.0°
number of constant u-velocity panels along a chord, NCW = 3
number of planar source panels along a chord, NCWT = 8
number of constant u-velocity panels along the span, MSWR = 5
(right horizontal fin)
MSWL = 5
(left horizontal fin)
MSWU = 5
(upper vertical fin)
MSWD = 5
(lower vertical fin)

number of planar source panels along the span is specified in subroutine THKIN of program DEMON2, MSWT = 5 for all fins
length of body interference shell, BIL = 3.6
radius of body interference shell, RB = 1.3
number of body interference panels on the circumference (ring), NBDCR = 16
number of body interference panel rings, NCWB = 3
distance from body nose to leading edge of lifting surface section, XWLE = 19.8 for canard, XWLE = 35.4 for tail

The thickness slopes are read in by subroutine THETIN of program DEMON2 and are determined as follows. The layout specified above for the planar source panels is shown by the thin lines superimposed on the fin planform in figure 4. At the centroid of each panel, the streamwise slope is to be specified. If the centroid lies on a bevelled portion of the fin, the streamwise slope equals the slope of the fin surface measured parallel to the fin rootchord. For centroids on the bevelled portion near the leading edge, the streamwise slope is given by

$$\text{THET} = \tan \theta_s = \frac{0.075}{0.6145} = 0.122 \tag{25}$$

On the unbevelled portion, the slope equals zero. Near the trailing edge, the streamwise slope equals

$$\text{THET} = \tan \theta_s = -\frac{0.075}{0.532} = -0.141 \tag{26}$$

Near the side edge, the streamwise slopes are chosen on the basis of the location of the source panel centroid on the fin. The above input parameters will be used in all runs with program DEMON2 described in the procedure for an axisymmetric body configuration, section 5.1.

6.1.2 Body nose vortices, pressure distributions on forebody

In accordance with step 1b described in section 5.1.1, program DEMON2 is run using the input data shown in figure 5. These data include the geometrical specifications and numbers of singularities laid out to represent the body-canard section of the complete configuration. The input data required by program DEMON2 is described in detail in Appendix J. Note that control index NCPOUT must be set equal to 1. The output of this run is shown in figure 6. It includes a printout of the data set, designated CPTS1, containing the 108 sets of coordinates of the control points distributed over the canard fins and the interference shell. This data set will be used later. The output also includes pressure coefficients as a function of polar angle for 10 axial locations from the body nose. The polar angle is named THETA and is measured positive counterclockwise from the positive y_B or y_W axis. The number of axial stations on the forebody at which the pressures are calculated is equal to one half of the body line singularities up to the canard section. Subroutine BDYVTX of program DEMON2 calculates the separation point to be at x_B = 17.2 inches or at about the fifth axial station. From that location on to the canard section, the shed vorticity is represented by two concentrated vortices growing in strength and moving in the crossflow plane in accordance with the data base built into subroutine BDYVTX.

The pressures acting on the forebody are calculated in subroutine BDYPR using the Bernoulli pressure expression, equation (10) in coefficient form. In terms of p/p_∞, where p_∞ is the free-stream static pressure, the pressures are plotted in figures 7(a) and 7(b) as a function of axial distance x_B from the body nose for several polar angles. The solid line represents pressures including body vortex effects. Pressures computed without effects of body vorticity are indicated by the crosses. From the onset of the body vortex shedding modeled by two discrete vortices, the Bernoulli pressures include effects induced by the external vortices and their images inside the body. Along the symmetrically located meridians, at θ = 45° and 225° on figure 7(a), the effect of the body vortices is to increase the pressures slightly. Note that the pressure distributions along these meridians are identical due to flow symmetry. However, the meridians at θ = 135° and 315°, figure 7(b) show no effect from the body vortices. On account of flow symmetry, the vortices and their images inside the body induce zero lateral velocity components along these meridians. Thus, the pressures are not affected by the body nose vortices along these meridians.

At the leading edge of the canard section, the body nose vortices are fully developed. The paths of the vortices as they pass through the canard section will now be determined and the canard fin loadings calculated.

6.1.3 Pressures and loads acting on the cruciform canard-body section

The pressures, forces and moments acting on the fins and body covered by the interference shell excluding body nose vortex effects are available in the output of the run performed with program DEMON2 just described. To account for the body vortices requires knowledge of their lateral coordinates as a function of axial distance through the canard region. In accordance with step 2 of the procedure, section 5.1.1, vortex tracking program VPATH2 is now employed to accomplish that task.

In order to improve accuracy, the strengths and positions of the body nose vorticity at the leading edge of the canard section are obtained from figure 5, reference 4, instead of the body pressure output mentioned above. For the last axial station, $x_B = 18.98$, at which body pressures are calculated as a result of the previous step, the body vortex strength, Γ/V_∞, equals 0.71. The canard leading edge is at $x_B = 19.8$ and the value for the body vortex strength equals 0.8024 in accordance with the cited figure. The lateral positions of the vortices are also determined at the canard leading-edge location. Body nose vortex strengths and lateral coordinates, in the body reference coordinate system, to be read in to program VPATH2 are given in the following table.

Γ/V_∞	$y_{B,V}$	$z_{B,V}$	$x_{B,V}$
0.8024	-0.64337	1.8382	19.8
-0.8024	-1.8382	0.64337	19.8

For this run with program VPATH2, indices NCPIN and NVLOUT are set equal to 1. After the vortex paths are calculated, the vortex induced velocities are determined at the control points on the canard fins and the interference shell. In this process, the vortices are in the presence of the body only. The purpose for this approach is described in section 3.4.

The input for program VPATH2 for this run is shown in figure 8. The output is shown in figure 9. It includes the lateral positions, in the body reference coordinate system, of the body nose vortices at the trailing edge of the canard section. They are given in the following table.

Γ/V_∞	$y_{B,V}$	$z_{B,V}$	$x_{B,V}$
0.8024	-0.68451	1.9192	23.4
-0.8024	-1.9192	0.68451	23.4

Comparison with the previous table indicates a small amount of lateral movement of the body vortices as they travel through the canard section. The vortices are located symmetrically with respect to the free-stream component in the crossflow plane. The output also shows the vortex induced velocities at the 108 control points associated with the canard fins and interference shell. Control point coordinates and vortex induced velocities are stored in a data set designated VELOS1.

In order to determine the effects of the body nose vortices on the canard section, program DEMON2 is run again in accordance with step 3 of section 5.1.1. The input for this run is the same as shown in figure 5 except for index NVLIN now set equal to 1 and index NCPOUT set equal to its default value 0. The forebody pressures appear unchanged in the output shown in figure 10. Vortex induced velocity components designated VVEL and WVEL are printed out under the heading POINT COORDINATES AND PERTURBATION VELOCITIES CALCULATED BY PROGRAM VPATH2 or VPATHL. These velocity components are included in the boundary conditions, equations (1) through (4), and the strengths of the constant u-velocity panels are recalculated. The pressures calculated at the control points on the fins and interference shell are changed because of the recalculated panel strengths and the inclusion of vortex induced velocities in the Bernoulli pressure determination.

Figures 11(a) and 11(b) show the pressure distributions on the forebody and over the length of the canard section. The latter are taken from program DEMON2 output under the heading AFT OF LEADING EDGE OF FIN ROOTCHORDS. As before, the solid line represents pressures calculated including the body nose vorticity; the crosses are pressures without body vorticity. For the symmetrically located meridians at $\theta = 56.25°$ and $\theta = 213.75°$, the effects of body nose vorticity are negligible over the canard section. Along the symmetrically located meridians at $\theta = 101.25°$ and $\theta = 168.75°$, the effects of the body vorticity are to increase the pressures. The output shown in figure 10 includes loadings for all fins based on linear pressure and Bernoulli pressure. In both cases, due to flow symmetry the loadings on the right horizontal and lower vertical fins are identical as are the loadings on the upper vertical and left horizontal fins. On the right horizontal fins, figure 12 shows slight effect of the body nose vorticity on the span loading. Due to the closer proximity of the upper vertical fin to the vorticity, the span loading is reduced significantly in the inboard region. In figure 13 the dashed curve (with vortices) exhibits a maximum and drops off in magnitude towards the fin root. In accordance with the analysis in Appendix B, this type of span load distribution gives rise to an inboard and outboard concentrated vortex at the trailing edge of this canard fin. The right horizontal fin does not show any extrema off the root and only one concentrated vortex results at the trailing edge. The leading edges of the fins are supersonic for the Mach number at hand so there is no leading-edge separation vortex in accordance with the analysis in Appendix C. The side edges of the fins give rise to a separation vortex with negligible strength as shown below. Thus, at the trailing edge of the canard section, the strengths and locations of body and canard vortices are assembled for the purpose of determining their paths to the base of the body. Their characteristics are taken from the output of program DEMON2 as a result of step 3, section 5.1.1. The body nose vortex specifications are taken from the output of program VPATH2 as a result of step 2.

Γ/V_∞	$y_{B,V}$	$z_{B,V}$	$x_{B,V}$		
0.8024	-0.68451	1.9192	23.4	body nose vortices	
-0.8024	-1.9192	0.68451	↓		
0.94911	3.15424	0.0	23.4	right hor. fin T.E. vortex	
0.05844	-2.09688	0.0		inboard	left hor. fin T.E. vortices
-0.59187	-3.46609	0.0		outboard	
-0.05844	0.0	2.09688		inboard	upper vert. fin T.E. vortices
0.59187	0.0	3.46609		outboard	
-0.94911	0.0	-3.15424	↓	lower vert. fin T.E. vortex	
0.01491	3.64	$\sim$0.0	23.4	right hor. fin S.E. vortex	
-0.01797	-3.64	$\sim$0.0		left hor. fin S.E. vortex	
0.01797	$\sim$0.0	3.64		upper vert. fin S.E. vortex	
-0.01491	$\sim$0.0	-3.64	↓	lower vert. fin S.E. vortex	

In this table, the trailing-edge vortex characteristics, GAMMA/VINF and Y.C.G. or Z.C.G., are obtained from the loading output under the heading BERNOULLI TYPE LOADING PRESSURE. The side-edge vortex characteristics, GAMMA,SE/VINF and YBAR or ZBAR, are obtained from the loading output under the heading U/VINF LOADING PRESSURE. The strengths of the side edge vortices are negligible compared to the strengths of the body nose and trailing edge vortices and will not be included in further analysis.

At the top of figure 14, all the vortices excepting the side-edge vortices listed in the above table are shown in position at the canard trailing edge, $x_B = 23.4$. They will eventually be tracked down the body through the tail section. However, before determining the vortex paths over the aft body, the body tail section must be dealt with in accordance with step 4 of section 5.1.1. Program DEMON2 is used again to model the body and the cruciform tail fins without accounting for the presence of body nose and canard fin vortices. The input for this run is the same as shown in figure 5 except that the distance from the nose to the tail section, XWLE, is now set equal to 35.4. Also, indices NCPOUT = 1, NVLIN = 0 and ITAIL = 1 in namelist $INPUT. Quantity XSTART is set equal to the trailing-edge location of the canard section, XSTART = 23.4. With these specifications, the program generates a data set, designated CPTS2, containing 268 sets of coordinates. Of this set, the first 108 sets pertain to the control points on the tail fins and interference shell. The remaining 160 are associated with points on the body aft of the canard section up to the tail section at which pressures will be calculated. The output for this run is not shown. The calculated pressures on the body meridians and the tail fin loadings do not include effects of body nose and canard vortices so far.

6.1.4 Vortex positions at body base, pressure distributions on aft body, tail fin loadings

Using program VPATH2, the vortices shown in the upper part of figure 14 are chased from the trailing edge of the canard section, past the aft body, through the tail section to the body base. In accordance with step 5 in section 5.1.1, the input to program VPATH2 for this run includes index NCPIN = 1 and index NVLOUT = 1. The input for this run is shown in figure 15. Under the influence of the free stream, the mutual interaction between the vortices and the effects of the presence of the body and tail section, the vortices move as a function of axial distance.

After the vortex paths have been determined, the vortex induced velocity components will be calculated at the 268 sets of coordinates associated with points on the aft body, tail fins and interference shell. Again, in this process the vortices are in the presence of the body only. The output of program VPATH2 is shown in figure 16. The bottom half of figure 14 shows the vortices at the base of the body as taken from the output at the x_B = 39.0 station (x-station no. 26). Comparison with the upper half shows that the body nose vortices did not move nearly as much as the vortices associated with the fins. The output also includes the velocity components induced by the vortices at the set of 268 points read in to the program. The control point coordinates and the induced velocity components are stored in a data set called VELOS2.

As described in the last step 6 of section 5.1.1, program DEMON2 is applied one more time to the tail fins and body. However, in this instance the input to program DEMON2 includes index NVLIN = 1 and ITAIL = 1. The input is shown in figure 17. Vortex induced velocity components are now included in the flow tangency condition applied at the control points distributed over the fins, equations (1) through (14). They are also included in the Bernoulli pressures calculated by subroutine BDYPR over the aft body and the part of the body covered by the interference shell associated with the tail fins. The output of this run is shown in figure 18. The pressure distributions and forces and moments acting on the tail fins now include effects induced by the body and canard fin vortices.

The pressures calculated along meridians at θ = 11.25°, 56.25° and 101.25° are shown in figure 19. The solid lines are the pressure distributions calculated including vortex effects and the crosses are calculated with vortices absent. The 11.25° and 101.25° meridians are on the suction sides of the right horizontal and upper vertical fins, respectively. Therefore, through the tail section, the pressures on these meridians are lower than the pressures on the 56.25° meridian. In general, over the aft body and through the tail section, the calculated effect of the body nose and canard vortices is to increase the pressures along the meridians shown.

The effect of the presence of vortices on the span loadings acting on the right horizontal and upper vertical fins are shown in figures 20 and 21. The tail fins are identical in geometry to the canard fins. Without vortices, the solid lines indicate that the span loading on the right horizontal and upper vertical fins are practically identical to those on the corresponding canard fins; see figures 12 and 13. However, in the tail region the body nose and canard vortices have larger influence in reducing the loadings on the two fins as shown in the figures by the dashed lines. On account of symmetry about the component of free stream in the crossflow plane, the loadings on the left horizontal fin are reduced to the same extent shown for the upper vertical fin in figure 21. Likewise, the loading on the lower vertical fin is reduced to the same extent indicated in figure 20.

6.2 Sample Case 2: Elliptic Cross Section Body-Monoplane Wing-Interdigitated Tails

The configuration of a model including a body with elliptical cross section is shown in figure 22. The body has an ellipticity ratio of 3. A monoplane wing and interdigitated tail fins with bevelled streamwise sections are attached to the body. Programs WDYBDY, DEMON2 and VPATHL are used to analyze this configuration at angle of attack of 10° and zero roll angle. The Mach number is 1.70. Under these conditions, there will be a symmetry plane at $y_B = 0$ in terms of the aerodynamic loading. Thus, only the right monoplane wing and the right upper and right lower interdigitated tail fins need to be modeled by program DEMON2. For the same reason, only the right half of the body needs to be modeled by source panels by means of program WDYBDY. Any vortices analyzed by program VPATHL will also be symmetrically positioned with respect to the $y_B = 0$ plane.

6.2.1 Geometry and singularity layout

The following geometrical specifications and singularity distributions will be used for the elliptical cross section body with monoplane wing and interdigitated tail fins. The specified numbers of body source panels to model the body and the numbers of chordwise and spanwise constant u-velocity panels to model the wing and tail fins give rise to a sparse layout. As such they may not be sufficient for precise calculated results but serve to generate this sample case. Refer to figures 22 in connection with input to program WDYBDY and figure 23 in connection with input to program DEMON2 for geometrical details.

The input to program WDYBDY includes the following specifications for the body with elliptic cross section. There will be two sets, depending on which lifting-surface section the effects of the body are to be determined.

Set #1 - Monoplane Wing Section

Body length to be modeled = 25.6 (covers the monoplane wing section)

Number of body source panels on the half circumference or half ring + 1 = KRAD, KRAD = 9 (8 panels/half ring)

Number of body source panels in the axial direction or number of rings + 1 = KFORX, KFORX = 11 (10 panels axially)

Body length over which pressures and loads are to be computed by program WDYBDY, XWLE = 18 (Program DEMON2 covers the winged section).

Set #2 - Interdigitated Tail Section

Body length to be modeled = 28.0 (covers the interdigitated tail section)

Number of body source panels on the half circumference or half ring + 1 = KRAD, KRAD = 9 (8 panels/half ring)

Number of body source panels in the axial direction or number of rings + 1 = KFORX, KFORX = 12 (11 panels axially)

The step for which this data is the partial input, no pressures and loads are computed

The first set will be used for the run with program WDYBDY in accordance with step 2, section 5.2.1, and the second set will be used for the run in accordance with step 9, section 5.2.1. The body source paneling layout associated with both sets is shown in figures 24(a), 24(b) and 24(c) in planview, sideview and cross section, respectively. Note that only the right half of the body will be modeled.

Namelist $INPUT in main routine CRFWBD of program DEMON2 includes specifications for the lifting surfaces and their associated interference shells. If the body is modeled by means of body source panels, as is the case here, it is important that the entire interference shell be exterior to the body source panels. If the shell were made to lie partially on the inside of the body outline, some of the control points distributed on the interference shell may lie on the interior side of one or more body source panels. In this case, the velocity components induced by the source panels at those points would be invalid.* As a consequence, the interference shells are laid out and the monoplane wing is idealized as shown in figure 23. For the monoplane wing attached to its interference shell with elliptic cross section, the input includes the following (refer to figure 23):

rootchord, CRP = 7.55
exposed semispan, B2 = 1.0935
leading edge sweep, SWLEP = 75.0°
trailing edge sweep, SWTEP = 30.016°
number of constant u-velocity panels along a chord, NCW = 2
number of planar source panels along a chord, NCWT = 4
number of constant u-velocity panels along the span, MSWR = 3
number of planar source panels along the span is specified in subroutine THKIN of program DEMON2, MSWT = 3
length of body interference shell, BIL = 7.55
horizontal semi-axis of elliptical interference shell, RB = 3.4641
vertical semi-axis of elliptical interference shell, RA = 1.155
Note: the ellipticity ratio, RB/RA = 3.0
number of body interference panels on the circumference (ring), NBDCR = 16
number of body interference rings, NCWB = 2
distance from body nose to monoplane wing section, XWLE = 18.0

The thickness slopes are read in by subroutine THETIN of program DEMON2. They are determined in the manner described for the first sample case, section 6.1.1. Using the detailed streamwise sections available from reference 11, the following streamwise slopes are used. For centroids of planar source panels near the leading edge, the streamwise slope is given by

*The solution associated with body source panels, reference 9, is valid only in the plane of the panel and along the outward normal.

$$\text{THET} = \tan\theta_s = \frac{0.125}{2.516} = 0.049692 \tag{27}$$

On the unbevelled portion, the slope equals zero. Near the trailing edge, the streamwise slope equals

$$\text{THET} = \tan\theta_s = -\frac{0.125}{1.5845} = -0.07889 \tag{28}$$

For the upper right and lower right interdigitated tail fins attached to its interference shell, the input includes the following (refer to figure 23). Thickness is not accounted for.

rootchord, CRP = CRPV = 3.6
exposed semispan, B2 = B2V = 3.6

upper right fin:

leading-edge sweep (varies with distance along the span),
VSWLER = 45.0° up to YRT = 2.0
VSWLER = 14.04° up to YRT = 3.6
Note: since leading-edge sweep varies, the trailing edge must also be specified as if it varies with distance along the span
trailing-edge sweep, VSWTER = 0.0 for all YRT

lower right fin:

leading-edge sweep (varies with distance along the span),
VSWLEU = 45.0° up to ZUT = 2.0
VSWLEU = 14.04° up to ZUT = 3.6
see note above
trailing-edge sweep, VSWTEU = 0.0 for all ZUT

number of constant u-velocity panels along a chord, NCW = 2
number of constant u-velocity panels along the span, MSWR = 4 (upper right fin)
MSWU = 4 (lower right fin)
length of body interference shell, BIL = 3.6
horizontal semi-axis of elliptical interference shell, RB = 3.129
vertical semi-axis of elliptical interference shell, RA = 1.043
Note: the ellipticity ratio, RB/RA = 3.0
number of body interference panels on the circumference (ring), NBDCR = 16
number of body interference panel rings, NCWB = 2

distance from body nose to tail section, XWLE = 24.4

angle of the location of the fins on the interference shell measured from positive y_w-axis, THETIT = 22.545°

dihedral angle of the fins, PHIDIH = 30°

Angles THETIT and PHIDIH are also indicated in figure 3. The above sets of input parameters will be used in the runs with programs WDYBDY and DEMON2 described in the procedure for a body with elliptical cross section, section 5.2.

6.2.2 Body nose vorticity, pressure distributions on forebody

After running program DEMON2 in accordance with step 1, section 5.2.1, to generate data set WCPTS, program WDYBDY is then run to model the body with elliptical cross section. The input to program WDYBDY includes the parameters in the first set described above and index NCWPT which must be set equal to the sum of all constant u-velocity panels on the monoplane wing and the interference shell. The length of body, to be modeled for this run, is taken to the trailing edge of the interference shell associated with the monoplane wing. The input for this run is shown in figure 25. For this case, the geometry of the body with elliptical cross section is given in terms of the horizontal semi-axis, FUSBY, and the vertical semi-axis, FUSAZ, as a function of axial location XFUS. Also included are the body nose vorticity characteristics, if indices NVTX and NXVTX are nonzero, provided by a separate program; see section 2.2. The axial stations at which this data is to be specified are read in from subroutine READVX and the lateral locations and strengths of the vortices are read in by subroutine ELBDVT. The output of this run is given in figure 26. Included in the output are the pressure coefficients designated CP and printed on the page identified with **FORMOM**. They are plotted in figures 27(a) and 27(b) from the body nose up to the leading edge of the monoplane wing section.

Figure 27(a) shows pressure distributions on the upper half of the body. The open symbols include effects of body nose vorticity. Pressure distributions without vortex effects are also shown by the solid symbols. In the legend, the first column of symbols are for meridians on which pressures are calculated over the forebody, the second column are for the monoplane wing section and the third for the tail section. For the moment, the forebody only is considered. The pressures shown in figure 27(a) are below free-stream static pressure. The effects of the specified body nose vortices are to increase the pressures along the θ = 9.07° meridian and to decrease the pressures along the θ = 31.41° meridian. On the lower half of the body, figure 27(b) shows that the effects of the body vortices are much less. Only one result is shown without vortex effects and there is little difference between the dark and light triangles. The output also includes the contributions from the forebody to the overall forces and moments under the heading TOTAL COEFFICIENTS ON THE BODY FROM XSTART = 0.0 to XWLE = 18.0. In order to improve the accuracy of these contributions, especially with vortex effects, the number of source panels should be larger than used here in this sample case.

Program WDYBDY also computes velocity components, induced by the body source panels only, at the control points distributed over the monoplane wing and interference shell read in by means of data set WCPTS. These velocity components are stored in a data set designated WVELS for later use by program DEMON2.

6.2.3 Pressures and loads acting on the monoplane wing-body section

After completing the calculations of pressures and loads acting on the forebody, program DEMON2 is applied to the monoplane wing-body section in accordance with step 3 of section 5.2.1. As a result of this run, the loadings acting on the monoplane wing section are calculated excluding effects of body nose vorticity. The output also includes the strength, $\Gamma/V_\infty\big|_{edge}$, and lateral position, $\bar{y}_W$, of the leading- and side-edge vorticity as a function of axial coordinate x_W. Values for these characteristics are taken from the loading output under the heading U/VINF TYPE LOADING PRESSURE. Leading-edge vorticity is designated GAMMA,LE/VINF, side-edge vorticity is GAMMA,SE/VINF, and the lateral location appears as YBAR. Along the leading-edge, the axial coordinate is XLE, along the side-edge it is XSE, both are in the wing coordinate system. The values shown in the following table are taken from the output of program DEMON2 for the right monoplane wing half. They are calculated with $K_{v,LE}$ = $K_{v,SE}$ = 0.5 (refer to Appendix C, equation C11, etc.). Note that x_W is the axial coordinate in the wing coordinate system.

x_W	$\bar{y}_W$	$\left.\frac{\Gamma}{V_\infty}\right\|_{edge}$	
0.66148	3.64135	0.27984	along leading edge
2.01812	3.82511	0.27786	
3.37295	4.03457	0.28634	
4.081	4.34073	0.44937	along side edge
6.13099	4.40075	0.58150	

Following step 4 of section 5.2.1, the vortex chasing program VPATHL is then employed to determine the paths of the two body nose vortices from the leading edge to the trailing edge of the monoplane wing section. The input for this run is shown in figure 28. Characteristics of the two symmetric body nose vortices at the start of the wing section are specified on the 9th line. Note that these two sets of characteristics are also shown in the input to program WDYBDY indicated in figure 25 at the last axial station associated with the forebody, XV = 18.0, on the cards marked YVRTX1, ZVRTX1, GAM1, and YVRTX2, ZVRTX2, GAM2, respectively. Also, the characteristics of the symmetric vortices on the opposite side of the plane of symmetry, $y_B = 0$ plane, must also be input to VPATHL. The starting values of the symmetric body nose vortex strengths and lateral positions are given in the following table with x_B, y_B and z_B in the body coordinate system.

x_B	y_B	z_B	$\left.\frac{\Gamma}{V_\infty}\right\|_{\text{Body nose}}$
18	2.35	1.673	1.52
18	-2.35	1.673	-1.52

The body nose vortex characteristics as a function of distance from the nose were determined by an adapted version of the program associated with reference 5 as mentioned earlier in section 2.2. Although the magnitude of the body nose vortex strength is at least 2.5 times the magnitude of the edge vorticity strength, for illustrative purposes the edge vorticity will be included in the determination of the body nose vortex paths. Thus, the input to program VPATHL shown in figure 28 also includes the edge vorticity specifications listed in the first table above. At this stage, the edge vorticity characteristics are only approximate in that the body nose vortex effects have not been included in the wing loading nor the edge vorticity distribution as calculated in step 3.

After the body nose vortex paths are known and the wing loading recalculated in step 5, described later, the updated edge vorticity distribution should be compared with the one given in the first table. If differences are sufficiently large, the calculations performed by steps 4 and 5 should be repeated until the edge vorticity distribution is converged.

Figure 29 shows the output of program VPATHL. The geometry of the monoplane plane wing in planform appears under the heading FIN GEOMETRY. The specified strengths and lateral coordinates of the leading- and side-edge vorticity as a function of axial distance measured from the body nose also appears on the first page of the output. The horizontal and vertical semi-axes of the body are held constant over the monoplane wing section. In fact, the body nose vortices pass over the idealized monoplane wing attached to the interference shell as indicated in figure 23. At the location corresponding to the trailing edge of the monoplane wing section, $x_B = 25.5$, the coordinates in the crossflow plane of the body nose vortices are given below.

x_B	y_B	z_B	$\frac{\Gamma}{V_\infty}$ Body nose
25.5	2.4609	1.8792	1.52
25.5	-2.4609	1.8792	-1.52

Comparison with the preceeding table shows that the body nose vortices move upward and outboard by a small amount. If the monoplane edge vorticity is neglected in the calculation of the body nose vortex paths, the results shown in the table below would be generated by program VPATHL. It is seen that for this illustrative example, the body nose vortices move higher but do not move as much outboard when the effects of edge

x_B	y_B	z_B	$\frac{\Gamma}{V_\infty}$ Body nose
25.5	2.4276	1.9509	1.52
25.5	-2.4276	1.9509	-1.52

vorticity are not included. In an actual calculation, the characteristics of the leading- and side-edge vorticity must be determined with a larger number of panels than is used in step 3. The last part of the output generated by program VPATHL contains the velocity components induced by the body nose vortices at the control points of the monoplane wing. These data are stored in data set VRTVEL.

In accordance with step 5 of section 5.2.1, program DEMON2 is run again to obtain the pressures acting on the monoplane wing-body section including effects of body nose vortices. In this run index NVLIN is set equal to 1 thereby causing data set VRTVEL to be read in. The input of program DEMON2 is shown in figure 30 for this run. Output generated by program DEMON2 is shown in figure 31. The last part contains the pressures acting along meridians on the interference shell under the heading AFT OF LEADING EDGE OF FIN ROOTCHORDS. Figures 27(a) and 27(b) include calculated pressures along 4 meridians on the interference shell. They are indicated by the second column of symbols and correspond to axial locations $x_B = 21.58$ and $x_B = 25.36$. These meridians are essentially the same* as the meridians for which pressures are plotted on the forebody. Over the upper half of the body, figure 27(a), the pressures through the monoplane wing section continue below free stream. Open symbols include effects of body nose vortex effects and the solid symbols are calculated excluding the body nose vortex effects. Along the $\theta_p = 11.25°$ meridian the effects of the vorticity is to increase the pressure appreciably and along the $\theta_p = 33.75°$ meridian the pressure is decreased. On the lower half of the body, the results shown on figure 27(b) show little effects from the body nose vorticity including the axial locations at $x_B = 21.58$ and 25.36.

The span-load distribution associated with the monoplane wing is shown in figure 32. The calculated results include body nose vortex effects. The solid line represents the potential span-load distribution which does not exhibit a maximum off the wing rootchord in contradistinction with the results computed for the cruciform canard of Sample Case 1 shown in figure 13 and discussed in section 6.1. For the indicated Mach number, the leading edge of the monoplane wing lies aft of the Mach cone with its vertex at the leading edge of the rootchord. Therefore, the leading edge is subsonic and the program calculates the suction distribution along that edge. Using the Polhamus vortex-lift analogy with the proportion of the leading edge suction converted to normal force equal

---

*Slight differences in polar angle are due to differences between geometry of body source panel layout and body interference panel layouts.

to 0.5 (refer to Appendix C), the dashed line represents the augmented span loading up to the side edge. The increments added to the potential span loading are obtained from the spanwise distribution CS*C/(2*B) for the right wing. They are calculated on the basis of linear pressure loading under the heading U/VINF TYPE LOADING PRESSURE, and must be multiplied by 0.5. The side edge also contributes to the calculated additional normal-force distribution which would be concentrated near the tip but is not shown in figure 32.

The augmentation to the normal-force coefficient for one wing half can be determined by multiplying the suction coefficient $C_S\big|_{LE}$ for the leading edge by the appropriate factor $K_{v,LE}$ and adding it to the suction coefficient for the side edge $C_S\big|_{SE}$ multiplied by the appropriate factor $K_{v,SE}$. The suction coefficient for the leading edge is proportional to the accumulated quantity CSINT(I) with index I equal to the number of panels in the spanwise direction. This number is equal to the quantity MSWR, specified in the input for program DEMON2, for the right wing half. In other words, the last value under the heading CSINT is taken from the spanwise distributions calculated on the basis of linear pressure loading of the lifting surface under consideration. This value must be multiplied by 2b where b is twice the exposed semispan, b/2, specified in the input of program DEMON2 and divided by the reference area S_{REF}. The suction for the side edge can be obtained from a numerical integration of the quantity SUCTION FORCE PER UNIT LENGTH/(Q*TIPCHORD) which appears under the heading SIDE EDGE DISTRIBUTION in the loading output calculated with linear pressure loading. Setting this quantity equal to $c_{S,JSE}$, the suction coefficient associated with the side edge is given by

$$C_S\Big|_{\text{side edge}} = \frac{(c_{TIP})^2}{S_{REF}} \sum_{JSE=1}^{NCW} c_{S,JSE} \cdot \frac{c_{TIP,JSE}}{c_{TIP}} \qquad (27)$$

In the above expression, c_{TIP} is the chord of the side edge or wing tip, S_{REF} is the reference area and NCW is the number of constant u-velocity panels in the chordwise direction. Thus for one wing half, the augmentation to the normal-force coefficient due to leading- and side-edge vorticity can be computed as follows.

$$C_N\Big|_{\substack{LE+SE\\ \text{vorticity}}} = K_{v,LE}C_S\Big|_{LE} + K_{v,SE}C_S\Big|_{SE} \qquad (28)$$

The vortex lift factors $K_{v,LE}$ and $K_{v,SE}$ are discussed in Appendix C.

The above process for the calculation of the augmentation to normal force due to leading- and side-edge vorticity must be repeated for each wing half. Since the flow conditions (including the presence of body nose vorticity) and configuration geometry are symmetric with respect to the $y_B = 0$ plane, the resulting loading on the body and lifting surfaces are also symmetric. Thus, the augmentation given by equation (28) must be doubled.

Finally, the updated characteristics of the monoplane wing leading- and side-edge vorticity also appear in the loading output under the heading U/VINF TYPE LOADING PRESSURE. They are listed below and at this stage (step 5) include effects of body nose vorticity. Comparison with the results excluding body nose vorticity shown in the first table of this section indicates an appreciable drop in strength and a slight outboard movement. On the basis of the difference in vorticity strength, an

x_W	$\bar{y}_W$	$\left.\frac{\Gamma}{V_\infty}\right\vert_{edge}$	
0.66148	3.64135	0.19406	along leading edge
2.01812	3.83365	0.19763	
3.37295	4.05562	0.21123	
4.081	4.36126	0.35606	along side edge
6.13099	4.41828	0.47179	

iteration would be recommended for an actual calculation. Note that a drop in edge vorticity strength would result in less influence in the body nose vortex path calculation. This should speed up the convergence mentioned earlier in this section.

6.2.4 Pressures and loads acting on the interdigitated tail-body section

According to figure 23, the monoplane wing-body section actually overlaps the interdigitated tail-body section. Thus, there is no afterbody separating the former from the latter. Consequently, steps 6 and 7 described in section 5.2.1 are omitted.

In dealing with the overlap situation, the following approximate procedure is adopted. The strengths and positions of the body nose vortices and the monoplane wing vortices are calculated by the preceding steps 4 and 5. The axial locations at which these characteristics are now known vary a little. The body nose vortices are known at $x_B = 25.5$.

The monoplane wing vortices are calculated somewhat aft of this location on or slightly above the trailing edge at different spanwise locations. For the purpose of determining the effects on the interdigitated tails, the vortices are assumed to pass through the tail section in a direction parallel to the body centerline. Their lateral positions are taken from the results obtained earlier. The following table contains the coordinates in the crossflow plane and the strengths of the external vortices influencing the pressures and loads acting on the interdigitated tails and body section. They will be part of the input to program DEMON2 applied

y_B	z_B	$\frac{\Gamma}{V_\infty}$	
2.4609 -2.4609	1.8792 1.8792	1.52 -1.52	body nose vortices
4.41828 -4.41828	0.661 0.661	0.47179 -0.47179	combined LE and SE vorticity at TE of monoplane wing
4.38465 -4.38465	0.0 0.0	0.59704 -0.59704	TE vortices on TE of monoplane wing

to the tail section. Note that the strengths and positions of the symmetry vortices must also be specified. The body nose vortex characteristics appear in the output of program VPATHL for the last axial station at $x_B = 25.5$ as a result of step 4. The combined leading- and side-edge vorticity characteristics at the wing trailing edge are obtained from the output of program DEMON2 as a result of step 5. They are taken from the distribution of vorticity along the side edge under the heading U/VINF TYPE LOADING PRESSURE. The accumulated value of the side-edge vorticity added to the leading-edge vorticity is taken at the wing trailing edge. In other words, the last values in the columns headed YBAR and GAMMA,SE/VINF are listed above. The vertical displacement is determined on the basis of the leading- and side-edge vorticity leaving the monoplane wing surface at an angle equal to half the angle of attack seen by the wing. With a rootchord equal to 7.55, refer to figure 23, the vertical displacement at the trailing edge is given by

$$z_B = (7.55) \tan 5° = 0.661 \tag{29}$$

The trailing-edge vortex characteristics are taken from the loading information output generated by program DEMON2 as a consequence of step 5 described in section 5.2.1. Trailing-edge vortex strength(s) and position(s) are taken from the results calculated on the basis of Bernoulli type loading pressures. They appear under the heading T. E. FIN VORTEX INFO.

Before the loads on the interdigitated tail section can be determined, program DEMON2 must first be run in accordance with step 8 of section 5.2.1 for the purpose of generating the data set TCPTS containing the coordinates of the control points distributed over the tail fins and the interference shell. Index NCPOUT must be set equal to 2 for this fin. The input is otherwise the same as the input to be discussed in connection with step 10. Once data set TCPTS has been generated, step 9 involves the application of program WDYBDY to the entire body length (i.e. up to the base of the tail section). The primary function of this run is to calculate the store in data set TVELS the velocity components induced by the body source panels at the control points on the tail fins and body interference shell. This last data set will be passed back to program DEMON2 in accordance with step 10.

The loads acting on the interdigitated tail-body section are calculated by program DEMON2 as per step 10 of section 5.2.1. Effects of the body nose and monoplane wing vortices will be included. The strengths and positions in the crossflow plane of these external vortices are listed in the discussion above. The input is shown in figure 33 and includes the break in sweep of the tail fins as described in section 6.2.1. For this run involving interdigitated tails, control index NDRAG must equal its default value 0. With this control, the program will not compute in plane forces used in the determination of edge suction. Note that with the Mach number at hand (1.7), the leading edge of the tail fin is supersonic for both sweep angles. Thus, the leading edge would have zero suction in this case. At the present time, program DEMON2 cannot compute in plane forces nor span loadings if the lifting surfaces under consideration involve interdigitated fins.

The input in figure 33 also includes the 6 external vortices listed in the table above. Index NVRTX=6 in namelist $INPUT causes the program to read in the strengths and lateral coordinates of the 6 body nose and monoplane wing vortices. In figure 33, the vortex specifications start on the 9th line from the end of the input. The listed z_B (or z_W) coordinates of the two body nose vortices are slightly in error. The number

1.8809 should have been 1.8792. The output generated by program DEMON2 using the latter value appears in figure 34. As mentioned earlier, the influences of the external vortices are accounted for in the loading calculations on the basis of their paths being aligned with the body centerline.

Pressure distributions along the meridians of the interference shell indicated in figure 23 appear under the heading AFT OF LEADING EDGE OF FIN ROOTCHORDS. The outline of the interference shell is the idealization of the actual body contour. Figure 27(a) contains calculated pressure coefficients for two meridians, at $\theta_p = 5.64°$ and $\theta_p = 16.91°$, respectively, on the upper half of the body. Both correspond to locations on the body contour below the right upper tail fin; in fact they lie on the impact side of that fin at axial stations $x_B = 26.11$ and 27.91. The pressures in this region rise rapidly from the leading edge of the tail section to the trailing edge. On the lower half of the body, figure 27(b), pressure coefficients are shown for the $\theta_p = 298.09°$ and $\theta_p = 354.36°$ meridians through the tail section. These two meridians lie on opposite sides of the right lower fin. Consequently, the pressure on the body below the fin ($\theta_p = 298.09°$) is higher than the pressure above the fin ($\theta_p = 354.36°$).

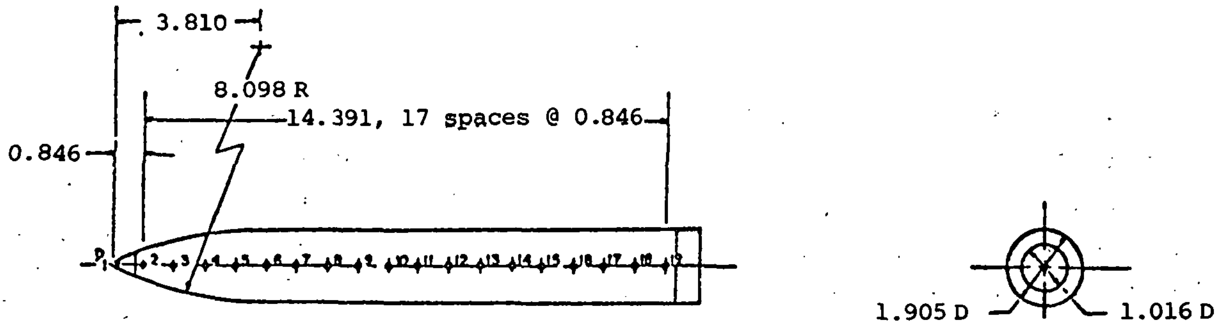
The pressure loading distributions for the upper and lower right fins appear under the heading PRESSURE LOADING AT CONTROL POINTS. Results are available on the basis of linear pressures under the heading DELTP,LIN., and on the basis of Bernoulli pressures under the heading DELTP,BERN. Forces acting on the fins in coefficient form are shown in the loading information output also for both types of loading pressures. If the effects of the body nose vortices are omitted, the loadings on the upper fins of the interdigitated tail section would be increased.

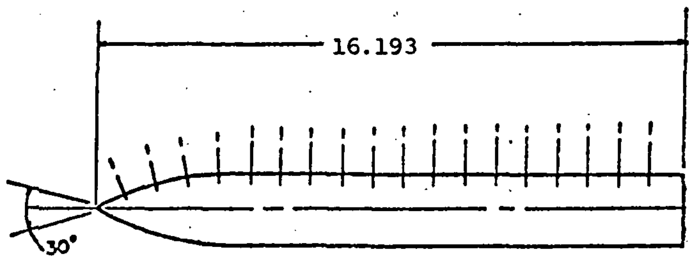
7. COMPARISON WITH EXPERIMENTAL DATA

During the development of the axisymmetric body modeling and pressure calculation methods described in section 3, some comparisons were made with experimental data. The ogive cylinder model shown at the top of figures 35, 36 and 37 is in fact the pressure distribution model used in connection with the store separation work associated with references 12, 13, and 14. This model is equipped with 19 pressure taps and the dimensions in inches are shown below. At the angle of attack under consideration

(5°), very little if any body vorticity will be generated. Thus, calculations were performed using program DEMON2.

The ogive cylindrical body is modeled with 30 line sources/sinks to account for volume effects and 30 line doublets to account for angle of attack. The calculated results are computed by subroutine BDYPR in conjunction with subroutine BDYGEN of program DEMON2. They are represented by a solid line in figure 35 for $M_\infty = 1.5$, in figure 36 for $M_\infty = 2.0$ and in figure 37 for $M_\infty = 2.5$. Program DEMON2 is not capable of modeling a body alone in its present state. Thus, near the body base a set of fins are attached as far as that program is concerned. The solid line is terminated at the leading edge of this imaginary fin section.





All dimensions in cm.

In general, the calculated results match the data well for all three Mach numbers. Near the body nose, some differences are evident for the two lower Mach numbers, figures 35 and 36. It is interesting to note that if the linear pressure relationship is used instead of the Bernoulli expression, the results near the nose tip are improved. However, at other locations, the agreement is then diminished. At the highest Mach number, $M_\infty = 2.5$, the Mach cone at the nose tip intersects the body. The part of the body nose outside of the Mach cone is then idealized by a conical surface, in fact by the Mach cone itself. In addition, as described in section 3, subroutine BDYGEN moves the line singularities up towards the nose in an effort to minimize the errors attendant to this approximation and the method of body modeling employed. Even so, if the pressure were calculated on the body between the nose tip and the location where the Mach cone emerges, the body singularities would have no effects. Thus, this constitutes a limit to the applicability of the body modeling method. Note that in figure 37 the most forward static pressure tap lies behind the intersection of the Mach cone and the body so that this location is affected by the forward line singularities.

8. CONCLUDING REMARKS

Existing cruciform wing-body computer programs have been extended and additional programs developed to compute, in a stepwise manner, pressure distributions acting on complete missile configurations. The applicable flow regime is supersonic and the configuration can be at combined angle of pitch and sideslip. The body can be circular or elliptic in cross section. The lifting surfaces can be a cruciform canard and/or curciform tail or a monoplane wing and interdigitated tail fins. Effects of body nose- and canard- or monoplane wing-vortices, tracked along the configuration, can be accounted for in the body pressures and tail fin loadings. For cases involving axisymmetric bodies, the body nose shed vortex characteristics are built into the program. Two calculative examples are given: the first concerns a cruciform canard-axisymmetric body-cruciform tail configuration and the second involves a monoplane wing-elliptic cross section body-interdigitated tail configuration. Limited comparisons between calculated and measured pressures are shown for an ogive cylinder at 5° angle of attack. Fin loads comparisons are described in earlier work. Fin edge vorticity characteristics are calculated by the program from the suction distributions using Polhamus' vortex lift analogy. Some comparisons with other theories are shown for leading- and side-edge suction forces in an appendix.

Some of the limitations of the program in their range of applicability are pointed out in this report. The limitations discussed herein are consequences of the basic linear methods used to model the components or to account for effects of vortices on the components. The limitation in applicability with regard to flow conditions is estimated to be about 20° in included angle of attack and supersonic velocities up to Mach number 3. A better estimate of the limitations of the program must await detailed pressure distribution data not now available.

The precision of the calculative method is associated with the number of body source panels used to model bodies with elliptical cross section, the number of discrete vortices used to represent body nose vortex shedding, and the number of constant u-velocity panels used to model the lifting surfaces.

The behavior of a vortex in the close proximity of a lifting surface can be a limiting factor in accuracy of prediction. It is possible to include a core in the model for the purpose of reducing the effect of the singularity in tangential velocity associated with the potential vortex model. To the best of our knowledge, there are no data available as yet for the vortex-shedding characteristics associated with bodies with elliptical cross section. A predictive program is available, as discussed herein, but must be thoroughly tested against experimental data not yet available.

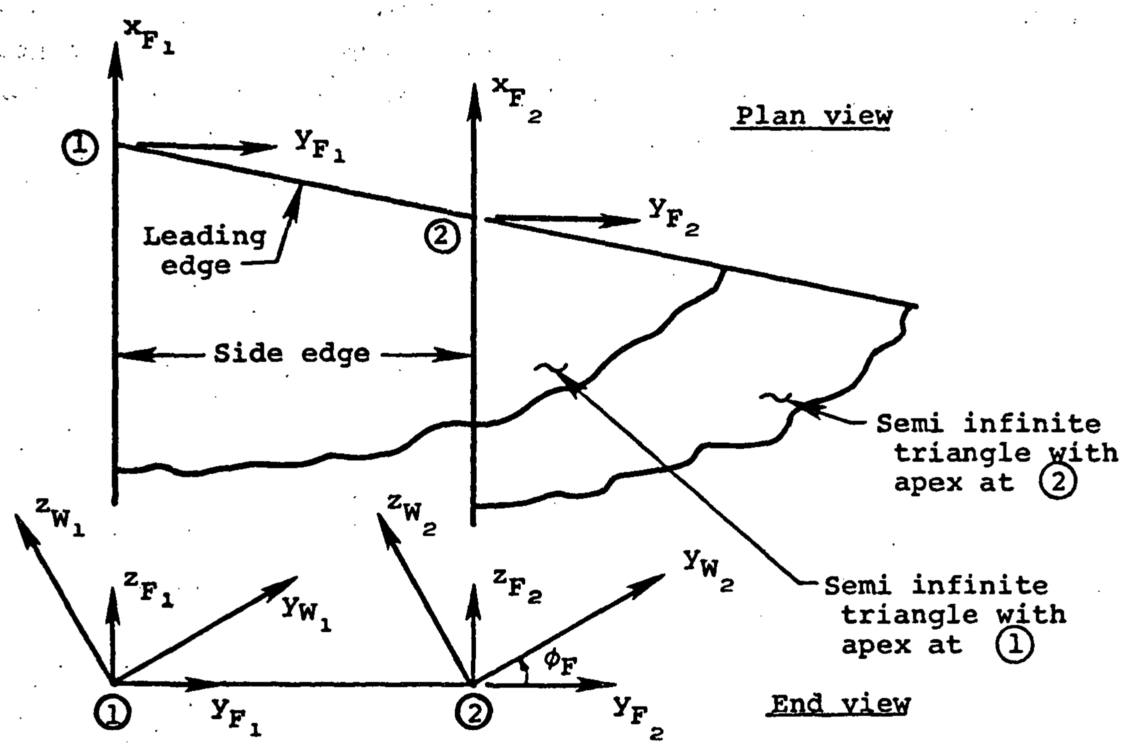
At the present time, the programs are used in a sequential manner without the benefit of an executive program. Running time is a function of the number of panels used. Some decrease in running time is possible by further refining the program.

APPENDIX A

SUPERPOSITION OF CORNER SOLUTIONS FOR A CONSTANT u-VELOCITY PANEL AT ARBITRARY DIHEDRAL ANGLE

In representing fin configurations by a distribution of constant u-velocity panels, questions arise concerning the coordinate system used in the panel corner superposition scheme. The superposition scheme is described in references 1 and 7. Furthermore, if the configuration geometry and flow conditions dictate symmetry in the flow field around the configuration, the aerodynamic influence coefficient matrix must reflect that condition. This appendix addresses these two topics in relation to the wing-body program DEMON2 only.

For simplicity consider only the corners on the leading edge of a constant u-velocity panel. Corners on the trailing edge are treated in the same manner. The following sketch shows the plan view and end view of the leading- and side-edges. Also indicated are the local panel coordinate systems with origins at panel corners 1 and 2. Axes x_{F_1}, y_{F_1} and axes x_{F_2}, y_{F_2} lie in the plane of the panel ($z_{F_1} = 0$, $z_{F_2} = 0$).



The end view shows the local lateral coordinates (y_{W_1}, z_{W_1}) and (y_{W_2}, z_{W_2}) with origins at corners 1 and 2, respectively. They are parallel to the reference wing coordinate system (x_W, y_W, z_W), and we will need velocity components in this system. Coordinate systems (x_{F1}, y_{F1}, z_{F1}) and $(x_{W_1}, y_{W_1}, z_{W_1})$ are different by a rotation about the x_{F_1} or x_{W_1} axis through fin dihedral angle ϕ_F. The same is true for the two systems at corner 2. The leading edge shown above has positive sweep. The superposition principle states that the solution for this infinitely long panel is given by the solution associated with the semi-infinite triangle with its apex at corner 1 minus the solution associated with the semi-infinite triangle with its apex at corner 2. Thus, in terms of flow velocity components, the superposition scheme specifies the velocity components in the x_F, y_F, z_F directions as follows for the semi-infinite panel.

$$\left.\begin{aligned} u_{F,TOT} &= u_{F_1} - u_{F_2} \\ v_{F,TOT} &= v_{F_1} - v_{F_2} \\ w_{F,TOT} &= w_{F_1} - w_{F_2} \end{aligned}\right\} \qquad \text{(A1)}$$

The corresponding velocities in the wing coordinate system are obtained from those given by equation (A1) by means of a rotational coordinate transformation.

$$\left.\begin{aligned} v_{W,TOT} &= v_{F,TOT} \cos\phi + w_{F,TOT} \sin\phi \\ w_{W,TOT} &= w_{F,TOT} \cos\phi - v_{F,TOT} \sin\phi \end{aligned}\right\} \qquad \text{(A2)}$$

In equation (A1), the superposition principle is applied to the velocities expressed in the panel coordinate system (x_F, y_F, z_F). These velocities are then transformed to the wing coordinate system (x_W, y_W, z_W) as indicated in equation (A2).

Alternately, velocities v_{F_1}, w_{F_1}, and v_{F_2}, w_{F_2} can first be transformed into the wing coordinate system and the superposition applied to the result. The lateral velocity components in the wing coordinate system are obtained from the ones in the panel coordinate system as follows.

$$\left.\begin{array}{l} \left.\begin{array}{l} v_{W_1} = v_{F_1} \cos\phi + w_{F_1} \sin\phi \\ \\ w_{W_1} = w_{F_2} \cos\phi - v_{F_1} \sin\phi \end{array}\right\} \\ \\ \left.\begin{array}{l} v_{W_2} = v_{F_2} \cos\phi + w_{F_2} \sin\phi \\ \\ w_{W_2} = w_{F_2} \cos\phi - v_{F_2} \sin\phi \end{array}\right\} \end{array}\right\} \qquad \text{(A3)}$$

Applying the superposition scheme to the velocities in the wing system and substituting from equations (A3) has the result

$$v_{W,TOT} = v_{W_1} - v_{W_2} = (v_{F_1} - v_{F_2}) \cos\phi + (w_{F_1} - w_{F_2}) \sin\phi$$

$$w_{W,TOT} = w_{W_1} - w_{W_2} = (w_{F_2} - w_{F_2}) \cos\phi - (v_{F_1} - v_{F_2}) \sin\phi$$

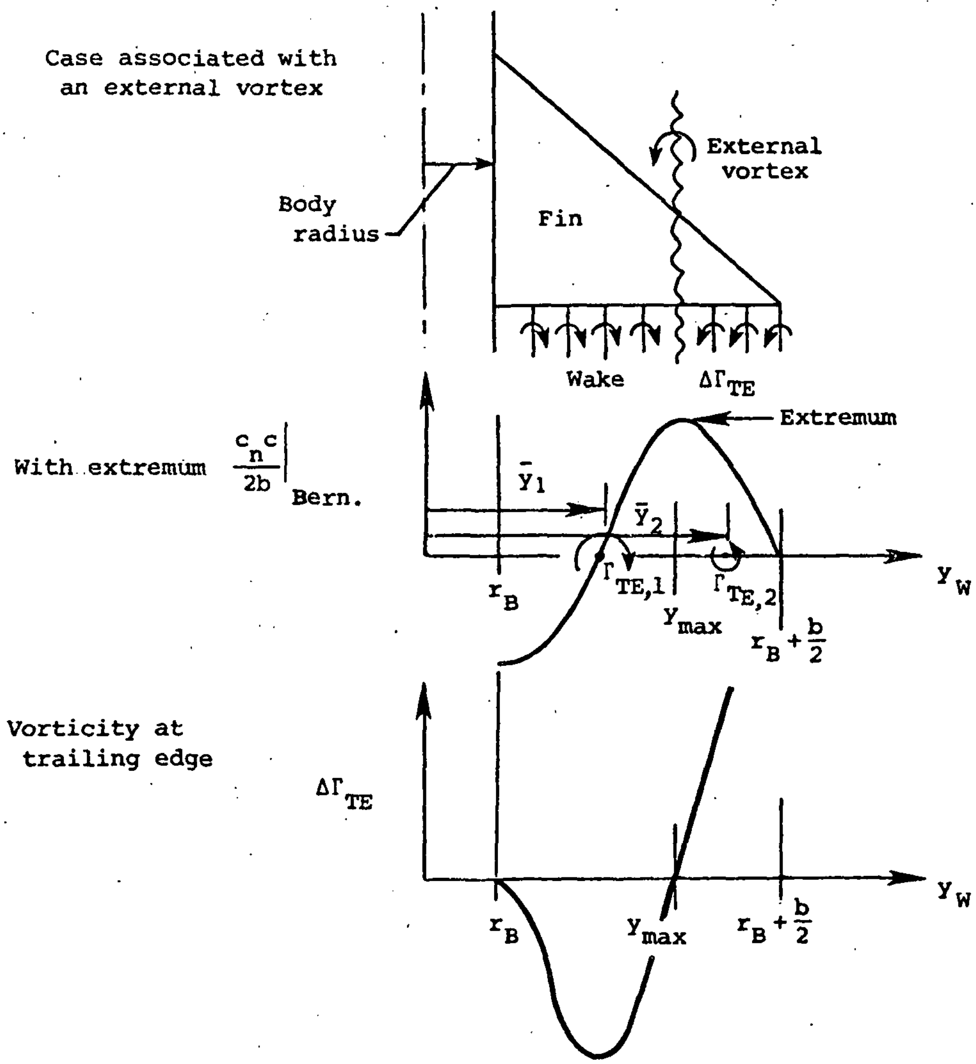
Or rewriting in terms of the quantities shown in equation (A1) then gives

$$\left.\begin{array}{l} v_{W,TOT} = v_{F,TOT} \cos\phi + w_{F,TOT} \sin\phi \\ \\ w_{W,TOT} = w_{F,TOT} \cos\phi - v_{F,TOT} \sin\phi \end{array}\right\} \qquad \text{(A4)}$$

This result is the same as the expressions shown in equation (A2). The conclusion is that the superposition scheme and the coordinate rotation can be interchanged. However, in program DEMON2, the actual procedure employed is as follows: In subroutine VELNOR, the coordinates of a given field point are first calculated relative to corner 1 in the wing reference coordinate system (x_W, y_W, z_W). These relative coordinates are then transformed to the local panel coordinate system (x_F, y_F, z_F) and the influence of the semi-infinite triangle with apex at corner 1 is calculated at the field point by a call to subroutine VELO. The induced velocities are returned in the local coordinate system and transformed back to the wing reference system. Before proceeding to corner 2, however, subroutine VELNOR checks on the possibility of symmetry, that is, for the case of zero sideslip or symmetry in the external vortices if present. If affirmative, the effect of the image corner on the opposite side of the body must be taken into account. To accomplish this, the field point instead is moved to its image point on the other side of the fuselage. The effect of the actual corner 1 is computed there in the wing coordinate system. The velocity components calculated in this way are then transferred to the actual field point with a change in sign on the side wash, v, aligned with the y_W-axis, if corner 1 belongs to a panel on the right horizontal fin. Thus, the procedure used to account for flow symmetry depends on expressing the velocity components in the wing reference coordinate system. The same procedure applies to all corners of panels at any dihedral angle. Thus, these panels include the constant u-velocity panels on cruciform fins, interdigitated fins, monoplane wings and the interference shell.

DETERMINATION OF STRENGTHS AND POSITIONS OF CONCENTRATED VORTICES AT THE FIN TRAILING EDGE

Consider a fin or a wing attached to a body as shown in the following sketch. An external vortex passes over the fin. The resulting span load distribution is indicated. The distribution at the trailing edge of the trailing-edge vorticity is also shown. It is desired to determine the strength(s) and location(s) of the concentrated vortex (vortices) representing the wake.



In order to represent the distributed trailing-edge vorticity by concentrated vortices, the spanwise load distribution based on the Bernoulli pressure expressions must be calculated first. For the case when this distribution exhibits extrema in between the end points, the number of concentrated vortices is given by the number of extrema plus 1. The trailing-edge vortex strength and position for the inboard portion of the normal-force distribution are then given by

$$\frac{\Gamma_{TE,1}}{V_\infty} = -\frac{1}{2}\int_{r_B}^{y_{max}} \frac{\partial}{\partial y}(cc_n)\,dy = -\frac{1}{2}\int_{r_B}^{y_{max}} d(cc_n) \tag{B1}$$

$$\bar{y}_1 = \frac{-\frac{1}{2}\displaystyle\int_{r_B}^{y_{max}} y\,\frac{\partial}{\partial y}(cc_n)\,dy}{-\frac{1}{2}\displaystyle\int_{r_B}^{y_{max}} \frac{\partial}{\partial y}(cc_n)\,dy} \tag{B2}$$

The basic relationship between the trailing-edge vorticity and the span-loading used here is described in detail in section 9.1 of reference 15. Fundamentally, it is shown that the rate of change in trailing-edge vorticity with spanwise distance equals the negative of the rate of change of the difference in potential between the upper and lower surfaces of the wing or fin. This is obtained by performing a contour integration parallel to the fin plane just behind the trailing edge. With simplifying assumptions, the potential difference (jump) at the trailing edge can be related to the span load distribution. The combination of these results leads to equation (B1). Integrating equation (B1) yields

$$\frac{\Gamma_{TE,1}}{V_\infty} = -\frac{1}{2}\left[cc_n\Big|_{y_{max}} - cc_n\Big|_{r_B}\right] \tag{B3}$$

and integration of equation (B2) by parts results in

$$\bar{y}_1 = \frac{-\frac{1}{2}\left[y(cc_n)\Big|_{r_B}^{y_{max}} - \int_{r_B}^{y_{max}} (cc_n)\,dy\right]}{-\frac{1}{2}\int_{r_B}^{y_{max}} d(cc_n)}$$

$$\bar{y}_1 = \frac{y_{max}\ cc_n\Big|_{y_{max}} - r_B\ cc_n\Big|_{r_B} - \int_{r_B}^{y_{max}} (cc_n)\,dy}{cc_n\Big|_{y_{max}} - cc_n\Big|_{r_B}} \tag{B4}$$

After splitting up the terms, the spanwise location of the inboard vortex is

$$\bar{y}_1 = \frac{y_{max}\ cc_n\Big|_{y_{max}} - r_B\ cc_n\Big|_{r_B}}{cc_n\Big|_{y_{max}} - cc_n\Big|_{r_B}} - \frac{\int_{r_B}^{y_{max}} (cc_n)\,dy}{cc_n\Big|_{y_{max}} - cc_n\Big|_{r_B}} \tag{B5}$$

The strength and position of the outboard vortex is obtained in the same fashion by changing the limits of integration.

$$\frac{\Gamma_{TE,2}}{V_\infty} = -\frac{1}{2}\int_{y_{max}}^{r_B + \frac{b}{2}} d(cc_n)$$

$$= -\frac{1}{2}\left[\cancel{cc_n\Big|_{r_B + \frac{b}{2}}}^{\,0} - cc_n\Big|_{y_{max}}\right] \tag{B6}$$

Since the spanwise loading is zero at the side edge, equation (B6) simplifies to

$$\frac{\Gamma_{TE,2}}{V_\infty} = \frac{1}{2}\, cc_n \Big|_{y_{max}} \qquad \text{(B7)}$$

The spanwise location at the trailing edge is given by equation (B2) with the proper limits of integration

$$\bar{y}_2 = \frac{-\frac{1}{2}\displaystyle\int_{y_{max}}^{r_B + \frac{b}{2}} y\, \frac{\partial}{\partial y}(cc_n)\,dy}{-\frac{1}{2}\displaystyle\int_{y_{max}}^{r_B + \frac{b}{2}} d(cc_n)} \qquad \text{(B8)}$$

After integration by parts, the result is

$$\bar{y}_2 = \frac{\cancelto{0}{(r_B+\frac{b}{2})\, cc_n \Big|_{r_B+\frac{b}{2}}} - y_{max}cc_n \Big|_{y_{max}}}{\cancelto{0}{cc_n \Big|_{r_o+\frac{b}{2}}} - cc_n \Big|_{y_{max}}} - \frac{\displaystyle\int_{y_{max}}^{r_B+\frac{b}{2}} (cc_n)\,dy}{\cancelto{0}{cc_n \Big|_{r_\Delta+\frac{b}{2}}} - cc_n \Big|_{y_{max}}}$$

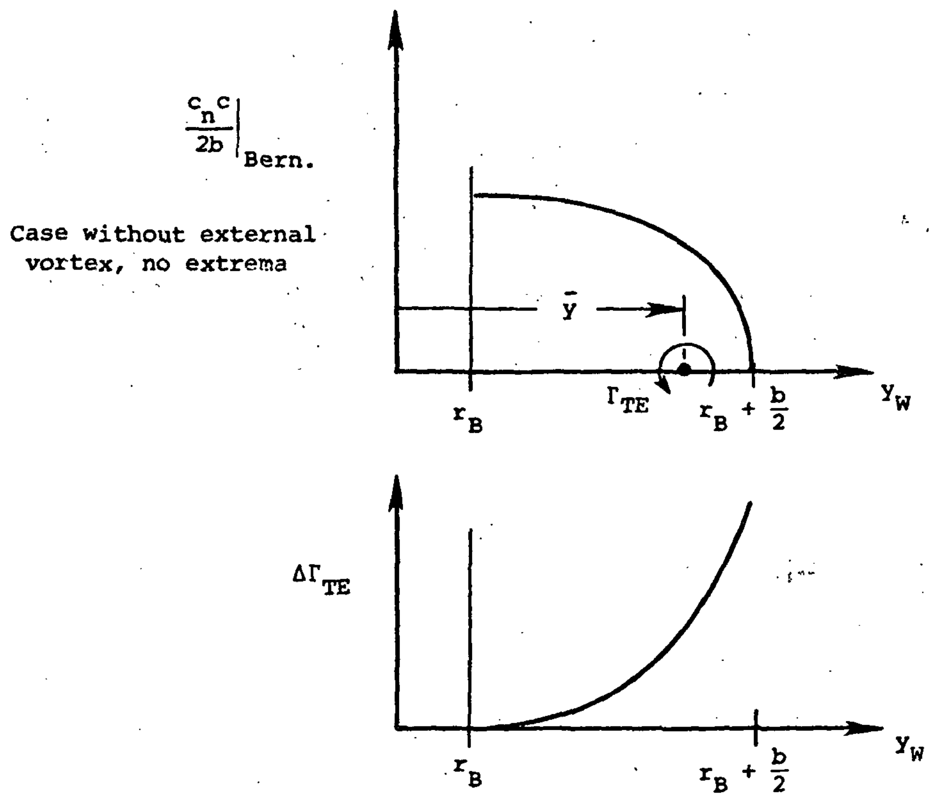
$$= \frac{-y_{max}\, cc_n \Big|_{y_{max}}}{-cc_n \Big|_{y_{max}}} - \frac{\displaystyle\int_{y_{max}}^{r_B+\frac{b}{2}} (cc_n)\,dy}{-cc_n \Big|_{y_{max}}}$$

and finally

$$\bar{y}_2 = y_{max} + \frac{\int_{y_{max}}^{r_B+\frac{b}{2}} (cc_n)\,dy}{cc_n\big|_{y\ max}} \tag{B9}$$

If the span-load distribution exhibits additional extrema, equations (B3) and (B5) must be applied again with the appropriate limits of integration $y_{max,1}$ to $y_{max,2}$. For the outboard vortex, equations (B7) and (B9) hold.

For the sake of completeness, expressions for the strength and spanwise location of the trailing-edge vorticity will be given for the case of spanwise load distributions such as the one shown below. Only one concentrated vortex is associated with this type of distribution.



Equations (B1) and (B2) are applied again with the upper limit of integration changed to $r_B + \frac{b}{2}$. The results are

$$\frac{\Gamma_{TE}}{V_\infty} = -\frac{1}{2} \int_{r_B}^{r_B+\frac{b}{2}} \frac{\partial}{\partial y}(cc_n)\,dy \tag{B10}$$

$$\bar{y} = \frac{-\frac{1}{2} \int_{r_B}^{r_B+\frac{b}{2}} y \, \frac{\partial}{\partial y}(cc_n)\,dy}{-\frac{1}{2} \int_{r_B}^{r_B+\frac{b}{2}} \frac{\partial}{\partial y}(cc_n)\,dy} \tag{B11}$$

Integrating equation (B10) gives

$$\frac{\Gamma_{TE}}{V_\infty} = -\frac{1}{2}\left[\cancelto{0}{cc_n\Big|_{r_B+\frac{b}{2}}} - cc_n\Big|_{r_B}\right]$$

and since the wing loading vanishes at the side edges, there results

$$\frac{\Gamma_{TE}}{V_\infty} = \frac{1}{2}\, cc_n\Big|_{r_B} \tag{B12}$$

After integration by parts, equation (B11) becomes

$$\bar{y} = \frac{-\frac{1}{2}\left[y(cc_n)\Big|_{r_B}^{r_B+\frac{b}{2}} - \int_{r_B}^{r_B+\frac{b}{2}} (cc_n)\,dy\right]}{-\frac{1}{2}\,(cc_n)\Big|_{r_B}^{r_B+\frac{b}{2}}}$$

Making use again of the fact that the wing load is zero on the side edge simplifies the above equation to

$$\bar{y} = \frac{-r_B(cc_n)\Big|_{r_B} - \int_{r_B}^{r_B+\frac{b}{2}}(cc_n)\,dy}{-cc_n\Big|_{r_B}}$$

or

$$\bar{y} = r_B + \frac{\int_{r_B}^{r_B+\frac{b}{2}}(cc_n)\,dy}{cc_n\Big|_{r_B}} \tag{B13}$$

Subroutine SPNLD in program DEMON2 generates discrete values for the spanwise loading $c_n c/2b$ at specific y locations. The extrema are searched for. The integrals appearing in equations (B5) and (B9) can then be represented by finite summations. For example, if for a fin the number of y stations up to y_{max} is MSW_{max} and the total number of y stations is MSWR then the integrals are rewritten as follows.

$$\int_{r_B}^{y_{max}} (cc_n)\,dy = 2b \sum_{i=1}^{MSW_{max}} \frac{c_n c}{2b}\Big|_i \Delta y_i \tag{B14}$$

and

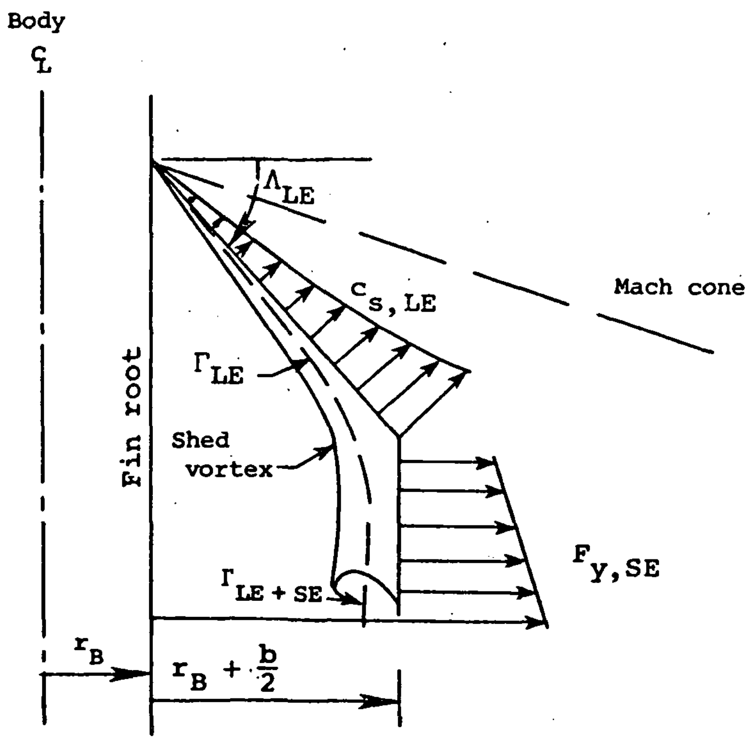
$$\int_{y_{max}}^{r_B + \frac{b}{2}} (cc_n)\,dy = 2b \sum_{i=MSW_{max}}^{MSWR} \frac{c_n c}{2b}\Big|_i \Delta y_i \tag{B15}$$

Subroutine SPNLD then proceeds to compute Γ_{TE}/V_∞ designated as GAMMA and $\bar{y}$ as YCG in accordance with equations (B5) and (B9). Note again that in all of the above the span loading is based on the Bernoulli pressure calculation.

APPENDIX C

CALCULATION OF LEADING- AND SIDE-EDGE VORTICITY DISTRIBUTIONS

This appendix contains a description of the improved method used to calculate leading- and side-edge vorticity characteristics associated with cruciform fins on bodies in supersonic flow. First the distributions of suction force acting on these edges must be determined. Then Polhamus' leading-edge suction analogy, reference 3, is used and applied also to the side edges. As a consequence of this analogy, the normal force acting on a lifting surface in supersonic flow is augmented by an amount proportional to the suction force acting on the leading- and side-edges for sharp edges. Consider the following sketch. It shows a general planform of a fin attached to a body. A schematic distribution of the suction force along the leading- and side-edge is also indicated. The objective is to determine the position and strength of the shed vortex from knowledge of the suction distribution. Note that if the leading edge is supersonic (this occurs when the Mach cone lies between the leading edge and the fin root chord), the suction force acting on that edge equals zero.



APPENDIX C

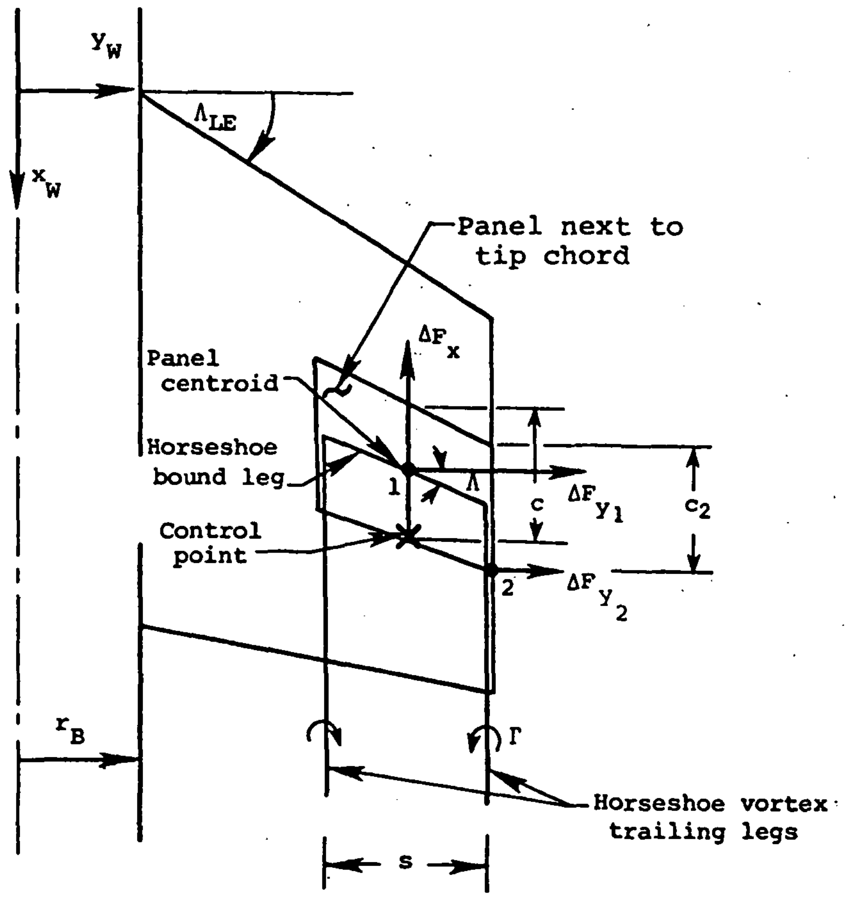
The method used to calculate the suction forces is described below in some detail. The subroutines in program DEMON2 concerned with the suction calculations are identified. The new procedure used for the side-edge suction calculation is pointed out. Calculated leading-edge thrust and suction-force distributions are compared with conical theory for the case of a slender delta wing. The predicted variation of side force along the side edge of a cropped delta wing is compared with two other theories. The side-edge suction factor, obtained using results computed by program DEMON2, is compared with conical theory for a case involving a rectangular wing.

After the suction distribution along the leading- and side-edges is described, the method used to convert the suction to edge vorticity is indicated.

Calculation of Suction Distribution

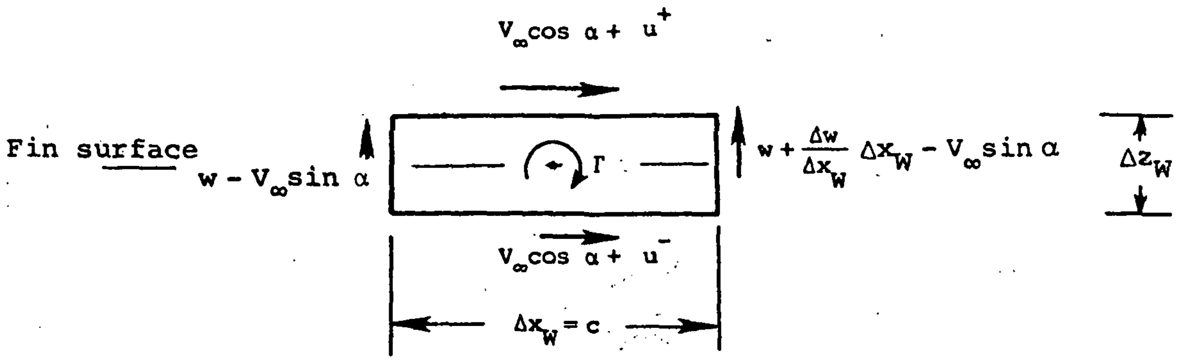
The present method used to calculate forces acting in the plane of a fin or wing in supersonic flow was first described in reference 1. For the sake of completeness, the important features and improvements to the method will be described here in the application to the determination of the suction forces acting on the leading edge and side edge of a fin.

First, the constant u-velocity panel strengths are recast in vorticity strengths. In fact, an equivalent vortex lattice is constructed using the same geometric paneling layout. The bound portion of each horseshoe vortex passes through the centroid of each constant u-velocity panel while the trailing legs extend in the streamwise direction as shown in the following sketch for a horizontal fin attached to a body.



A vertical fin attached to a body is treated in a similar manner. The above sketch also shows the in-plane force ΔF_x (acting in the negative x_w-direction) and side forces ΔF_{y_1} and ΔF_{y_2}. The quantity ΔF_{y_2} is the side force acting on the side edge for a distance $c_2/2$ forward of point 2 and a distance $c_2/2$ downstream of the point. It should be noted that the resultant in-plane forces must appear at the edges of the fin. The trailing edge has no such forces by virtue of the Kutta condition if subsonic, and in no event if supersonic. Thus, the elemental forces ΔF_x, ΔF_{y_1}, and ΔF_{y_2} summed over all the panels and vectorially added on a given fin appear either as leading- or side-edge suction forces.

The strength of the constant u-velocity panel is taken as the u-velocity in and immediately above its plane and is denoted u^+. The perturbation velocity immediately below, u^-, equals $-u^+$. The equivalent circulation can then be determined from the closed path (clockwise) integral of the product of the total velocity tangential to the path and the path length shown in the following sketch. Neglecting terms of higher



order in Δx, the equivalent circulation strength Γ is then given by

$$\frac{\Gamma}{V_\infty} = 2\ c\ \frac{u^+}{V_\infty} \tag{C1}$$

In subroutine *LOADS* of program *DEMON2*, the linear loading pressure acting on a panel is used instead of the panel strength u^+ in the determination of the equivalent circulation strengths. The linear loading pressure is related to the constant u-velocity panel strength as follows.

$$\left.\frac{\Delta p}{q}\right|_{\text{linear}} = 4\ \frac{u^+}{V_\infty} \tag{C2}$$

The circulation strengths are calculated using equations (C1) and (C2). The velocity normal to the panels induced by the constant u-velocity panels distributed on all fins and the body interference shell are then calculated and added to the contribution to the velocity normal to the fin induced by the singularities modeling the body. The in-plane forces can be calculated using the Kutta-Joukowski law for lift acting on a vortex filament. The forces acting on the bound vortex with sweep angle Λ and the side force acting on the outboard trailing leg of one panel are given by the following expressions. Angle α is the sum of the angle of pitch added to the fin deflection angle if applicable.

$$\frac{\Delta F_x}{q} = 2\ s\ \frac{\Gamma}{V_\infty}\left(\sin\alpha + \frac{w_1}{V_\infty}\right) \tag{C3}$$

$$\frac{\Delta F_{y_1}}{q} = \frac{\Delta F_x}{q}\tan\Lambda \tag{C4}$$

$$\frac{\Delta F_{y_2}}{q} = 2\ c_2\ \frac{\Delta\Gamma}{V_\infty}\left(\sin\alpha + \frac{w_2}{V_\infty}\right) \tag{C5}$$

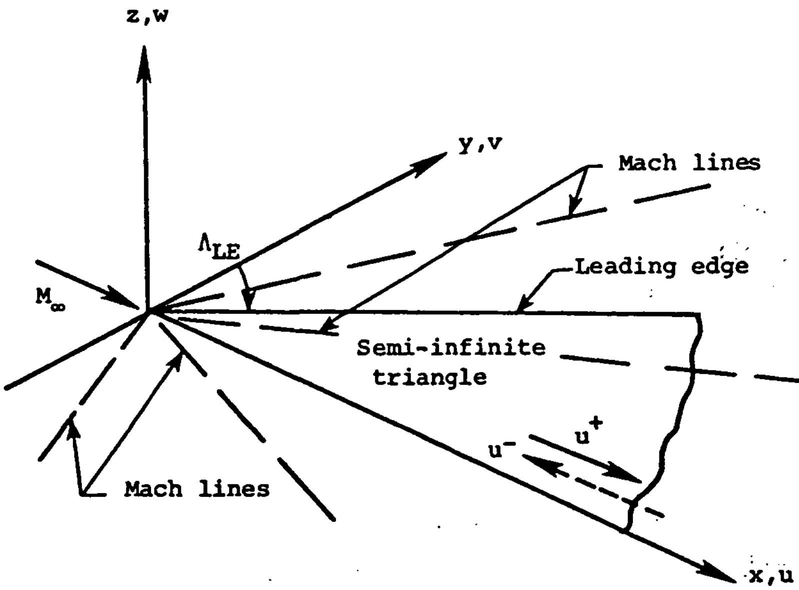
In equation (C5) $\Delta\Gamma$ is the sum of all the trailing vorticity along the panel side edge for all panels in the chordwise row ahead of the outboard aft corner. For the last panel c_2 is replaced by $c_2/2$. The above panel forces apply to panels on a horizontal fin. For panels on the vertical fin, y_1 and y_2 are replaced by z_1 and z_2, w_1 and w_2 are replaced by v_1 and v_2, $\sin\alpha$ is replaced by $\sin\beta$ and the sign inside the brackets is changed to negative. Perturbation upwash velocity w_1 is computed at the centroid of the panel and w_2 is computed at the aft outboard corner. The forces at the centroid, F_x and F_{y_1} divided by the dynamic pressure are computed in subroutine LOADS. The side force on the outboard leg is calculated in subroutine SPNLD of program DEMON2.

The forces calculated for every panel in accordance with equations (C3) through (C5) can be summed to obtain the net in-plane forces acting on a column (strip in chordwise direction) of panels and on the entire fin. If the number of panels in a given column is large, the vector sum of forces ΔF_x and $(\Delta F_{y_1} + \Delta F_{y_2})$ equals the suction force for that column acting in the direction normal to the leading edge. In order to obtain good results for the leading edge without having to resort to a large number of panels it was found advantageous to calculate the suction force from the sum of the F_x forces and the leading-edge sweep of the fin under consideration. The section coefficient for suction, c_s, is the suction force per unit span divided by qc, where c is the local chord. This section coefficient is calculated in nondimensional form in accordance with

$$\frac{c_s c}{2b} = \frac{\sum_{i=1}^{NCW} \left. \frac{\Delta F_x}{q} \right|_i}{s\ (2b)\ \cos \Lambda_{LE}} \tag{C6}$$

by subroutine SPNLD of program DEMON2. The index NCW is the number of panels in the chordwise direction. Panel width s is constant for a column of panels but can vary from one column to the next. By adding the contributions from all constant u-velocity panels distributed on a fin, excluding the outboard leg side forces of the panels at the tipchord, the summed in-plane forces F_x, F_{y_1} and F_{y_2} for the leading edge are computed in subroutine SPNLD. When divided by q_∞, they are designated SUMFX, SUMFY1 and SUMFY2, respectively, for horizontal fins (a horizontal fin lies in the $z_B = 0$ plane; see figure 1). Total forces F_x, F_{z_1} and F_{z_2} are designated SUMFX, SUMFZ1 and SUMFZ2, respectively, for the vertical fins (a vertical fin lies in the $y_B = 0$ plane). The forces acting on the outboard legs of panels at the fin tipchords are added separately and designated SUMFT2 in subroutine SPNLD. The sum represents the suction force on the side edge of the fin. Velocity components w_2/V_∞ (for horizontal fins) and v_2/V_∞ (for vertical fins) calculated at points on the side edge of fins with subsonic leading edges are calculated in accordance with the special procedure described next.

Consider a basic semi-infinite triangle with its apex at one of the corners of a constant u-velocity panel. The sketch below shows one semi-infinite triangle with two Mach lines corresponding to two free-stream Mach numbers. When the leading edge of the triangle lies inside the Mach cone, it is a subsonic leading edge. If it lies outside the Mach cone, the edge is supersonic. The outboard aft corner points of panels at the side edge, marked 2 on the second sketch of this appendix, lie on the extended leading and extended trailing edges of many panels inboard of the side edge panels. In particular, the point lies on the trailing edge of the panel shown in the sketch. If the edges are subsonic, the



contributions to the upwash from the semi-infinite triangles on whose leading edge the point lies are in fact singular as shown in figure II-1(a) in reference 7. To avoid numerical difficulties, subroutine VELO in program DEMON2 sets the downwash equal to zero. As a consequence, the points on the side edge of a fin with subsonic leading and trailing edges only receive upwash contributions from those basic semi-infinite triangles whose leading edges do not pass through the points. It was found that the side force calculated on the side edge of a cropped delta wing using the upwash, w_2, calculated this way was underestimated. By moving the points on the side edge off the fin a distance equal to the width of the nearest panel width, the values of the upwash are increased and more reasonable values for the side edge forces are obtained. For a cropped delta wing with supersonic leading and trailing edges the above problem does not exist. The upwash at the leading edge is discontinuous in this case; refer to figure II-1(c) in reference 7. The mean value is used.

A few examples will now be discussed. Consider figure C-1 first. It shows the distribution of thrust and suction along the leading edge of a delta wing with aspect ratio equal to 1. The Mach number is $\sqrt{2}$. The conical theory results for the linear thrust distribution shown by the lower dashed line, is based on the thrust coefficient calculated from the lift and drag coefficient for small angle of attack as follows.

$$C_T = \alpha C_L - \left(\frac{C_{D_i}}{C_L^2} \right) C_L = \frac{T}{q\ c_r\ (b/2)} \qquad \text{(C7)}$$

For a delta wing, page 292 in reference 8 contains expressions for lift and drag. The slope of the spanwise thrust distribution $cc_t/2b$ for the half wing is then related to the thrust coefficient by

$$k_T = \frac{\frac{C_T}{2} c_r}{2b} \qquad \text{(C8)}$$

where c_r is the rootchord. The suction coefficient of one wing half is related to the thrust through the leading edge sweep Λ of the leading edge.

$$C_S \Big|_{\text{half wing}} = \frac{\frac{C_T}{2}}{\cos \Lambda} = \frac{S}{c_r\ (b/2)\ q} \qquad \text{(C9)}$$

Therefore, the linear slope of the spanwise suction distribution is given by

$$k_S = \frac{C_S c_r}{2b} = \frac{k_T}{\cos \Lambda} \qquad \text{(C10)}$$

The results calculated by subroutine SPNLD in program DEMON2 with a layout of five chordwise and 20 spanwise panels agree well with the linear thrust distribution from conical theory. The suction coefficient is actually calculated on the basis of vectorially adding the forward and side forces acting on all the constant u-velocity panels. The results calculated from the program are higher than the conical result from the 70 percent spanwise station on although the curve tends to return to the conical value near the tip. Nevertheless, the resultant suction force calculated this way was almost exactly normal to the leading edge. If the values of $(c_t c)/2b$ are simply divided by $\cos \Lambda$, the resulting $(c_s c)/2b$ values, as indicated by the crosses, are very close to the conical results. However, the suction as calculated in the program is away from the normal to the leading edge by a few degrees.

The distribution of the suction force along the side edge of a cropped delta wing is shown in figure C-2. Results calculated by subroutine SPNLD of program DEMON2 are indicated by the solid circles. The solid line is a distribution calculated on the basis of conical theory and given by an adapted version of equation 10 on page 8 of reference 16. Certain restrictions are imposed on the application of the expression shown in figure C-2. For example, the Mach lines from the leading edges of the tip chords must not intersect the opposite wing tip. The dashed line represents an exact linear theory result obtained by J. N. Nielsen using some of the results derived in reference 17 and the lift-cancellation method. Other than close to the leading and trailing edges of the tip chord, the program results match the exact theory well. Overall suction force along the side edge calculated by the program is slightly below that calculated by the linear theory. For this case, the leading edges and trailing edges of the panels along the side edge are subsonic near the leading edge of the side edge and supersonic near the trailing edge. This is a mixed case and the offset scheme described above may not apply to all of the points on the side edge.

The last example of suction force calculation is shown in figure C-3 for the case of a rectangular wing. The result shown by the dashed line is based on conical theory and can be obtained by the methods employed by Lamar in reference 18 for rectangular wings. The solid line is the result calculated by the program using the following definition of $K_{v,SE}$, the side-edge suction coefficient.

$$K_{v,SE} = \frac{2(F_{y_2} + F_{T_2})}{qS_{Ref}\sin^2\alpha} \tag{C11}$$

Quantity F_{y_2}/q (SUMFY2 in subroutine SPNLD) is the sum of the in-plane forces, divided by the dynamic pressure, in the y_w-direction acting at the outboard aft corner of all the panels except those next to the side edge. Quantity F_{T_2}/q (SUMFT2 in subroutine SPNLD) is the sum of the forces, divided by the dynamic pressure, in the y_w-direction acting on the outboard aft corners of the panels at the side edge. Results were calculated for five panels in the chordwise direction as a function of the number of panels in the spanwise direction. The solid line approaches the conical theory result as the number of spanwise panels is increased. Increasing the number of chordwise panels also improves the agreement. With 10 along the chord and 15 along the span, the point marked by the cross corresponds to $K_{v,SE} = 1.099$.

Conversion of Suction to Edge Vorticity

With the distribution of suction along the leading and side edges of a given lifting surface calculated by the methods described above, the Polhamus analogy is used to convert the suction to additional normal force and accompanying edge vorticity. The analogy is described in reference 3 and states that at high angles of attack the normal force acting on a delta type wing is augmented by an amount proportional to the suction force acting on the leading edge. The additional lift is associated with flow separation along swept leading edges. This analogy is extended to the side edges of a wing or fin of general planform.

Section 6.2.3 contains a description of the procedure used to compute the increment in normal force due to edge vorticity from the suction force coefficients calculatable from quantities in the output of program DEMON2. In the following, the method for relating the distribution along the leading and side edges of suction force to the distribution of augmented normal force is indicated. Then, a discussion follows concerning the analysis required to relate the distribution of edge vorticity to the distribution of augmented normal force.

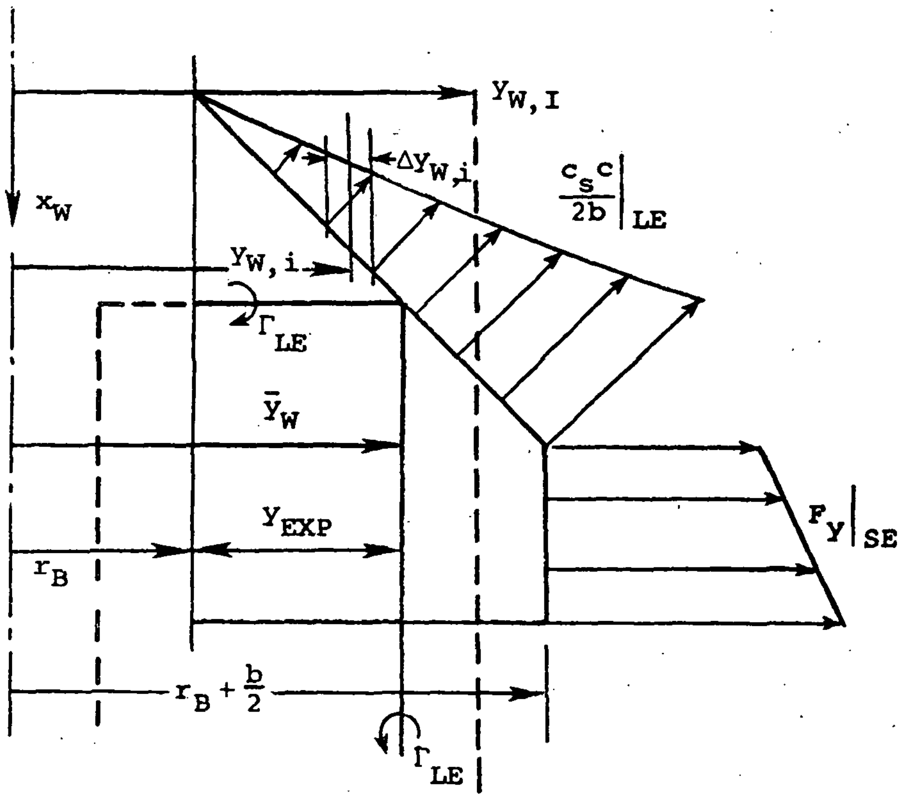
For the leading edge, the spanwise distribution of suction is given by equation (C6). Define $K_{v,LE}$, assumed constant, as the proportion of the suction converted to normal force

$$K_{v,LE} = \frac{\frac{\Delta c_n c}{2b}}{\frac{c_s c}{2b}} \tag{C12}$$

This factor is called the vortex lift vector for the leading edge. It is a function of leading edge sweep, Mach number and leading-edge geometry. For sharp edges, figure 9(a) in reference 4 contains graphs from which estimates can be obtained for $K_{v,LE}$ values as a function of aspect ratio and Mach number. In accordance with equation (30), the vortex lift factor $K_{v,LE}$ is also applicable to the suction coefficient associated with the entire leading edge to give the increment in normal force due to leading-edge vorticity (for one wing half)

$$K_{v,LE} = \frac{C_N|_{L.E.\ vorticity}}{C_S|_{L.E.}} \tag{C13}$$

Refer now to the sketch below. Schematic distributions of suction



are shown for the leading and side edge of the wing or fin attached to a body. Up to given spanwise position $y_{W,I}$ subroutine SPNLD of program DEMON2 integrates the spanwise suction distribution. The integrated quantity is named CSINT. It is equal to the suction force divided by 2b (b/2 is the exposed semispan of the fin) accumulated up to spanwise location $y_{W,I}$.

$$\text{CSINT} = \sum_{i=1}^{I} \frac{c_s c}{2b}\Big|_i \Delta y_{W,i} \tag{C14}$$

The moment of the suction force divided by factor 2b is formed as follows.

$$\text{CSMOM} = \sum_{i=1}^{I} y_{W,i} \left.\frac{c_s c}{2b}\right|_i \Delta y_{W,i} \tag{C15}$$

The spanwise location of the "center of gravity" of the suction distribution along the leading edge up to $y_{W,I}$ is given by the ratio of the moment over the force.

$$\left.\begin{aligned} \bar{y}_W &= \frac{\text{CSMOM}}{\text{CSINT}} \\ y_{EXP} &= \bar{y}_W - r_b \end{aligned}\right\} \tag{C16}$$

A horseshoe vortex is laid-out on the wing or fin attached to the body. The outboard trailing filament is at spanwise position $\bar{y}_W$. The lift acting on the bound or spanwise leg is made equal to the increment in normal force due to leading-edge vorticity. Up to spanwise location $y_{W,I}$, the increment in normal force in coefficient form is given by equation (C13) in conjunction with equation (C14).

$$C_N\Big|_{\text{L.E. vorticity}} = K_{v,LE}\ (\text{CSINT})\,2b \tag{C17}$$

Taking the component in the direction of the lift force results in

$$C_L\Big|_{\text{L.E. vorticity}} = K_{v,LE}\ (\text{CSINT})\,2b \cos\alpha \tag{C18}$$

where α is the angle of attack seen by the lifting surface in question. Then, with the Kutta-Joukowski law for lift on a vortex filament, the vortex strength Γ_{LE} associated with the added lift can be obtained from the following approximate relation.

$$\frac{\Gamma_{LE}}{V_\infty} = \frac{K_{v,LE}\ (\text{CSINT})\,2b \cos\alpha}{2y_{EXP}} \tag{C19}$$

This relation is correct for a wing alone ($r_b = 0$) for which the span of the horseshoe vortex would be equal to 2 $\bar{y}_W$ or 2 y_{EXP}. However, for a wing or fin attached to a body as shown in the sketch above, the span or width of the horseshoe vortex is the difference between $\bar{y}_W$ and the distance from the body centerline to the image (shown dashed) of the outboard trailing filament, $r_b^2/\bar{y}_W$. At the present time, equation (C19) is programmed in subroutine SPNLD of program DEMON2. In any event, equation (C19) provides the spanwise distribution of Γ_{LE} and its location $\bar{y}_W$ is given by equation (C16).

A similar procedure is followed for determining the strength and spanwise location of vorticity along the side edge. The summing process indicated in equation (C14) to calculate quantity CSINT is continued along the side edge using the side force designated $FT_2(J_{TIP})$ and computed in accordance with equation (C5). The vorticity associated with the added normal force is also determined by expressions (C18) and (C19) replacing $K_{v,LE}$ with $K_{v,SE}$. The same remarks made above in connection with the spanwise width apply. In addition, it is recommended to set $K_{v,SE} = K_{v,LE}$ for use in the program as written at the present time. Note that these vortex lift factors have the default value 0.5 in main routine CRFWBD of program DEMON2.

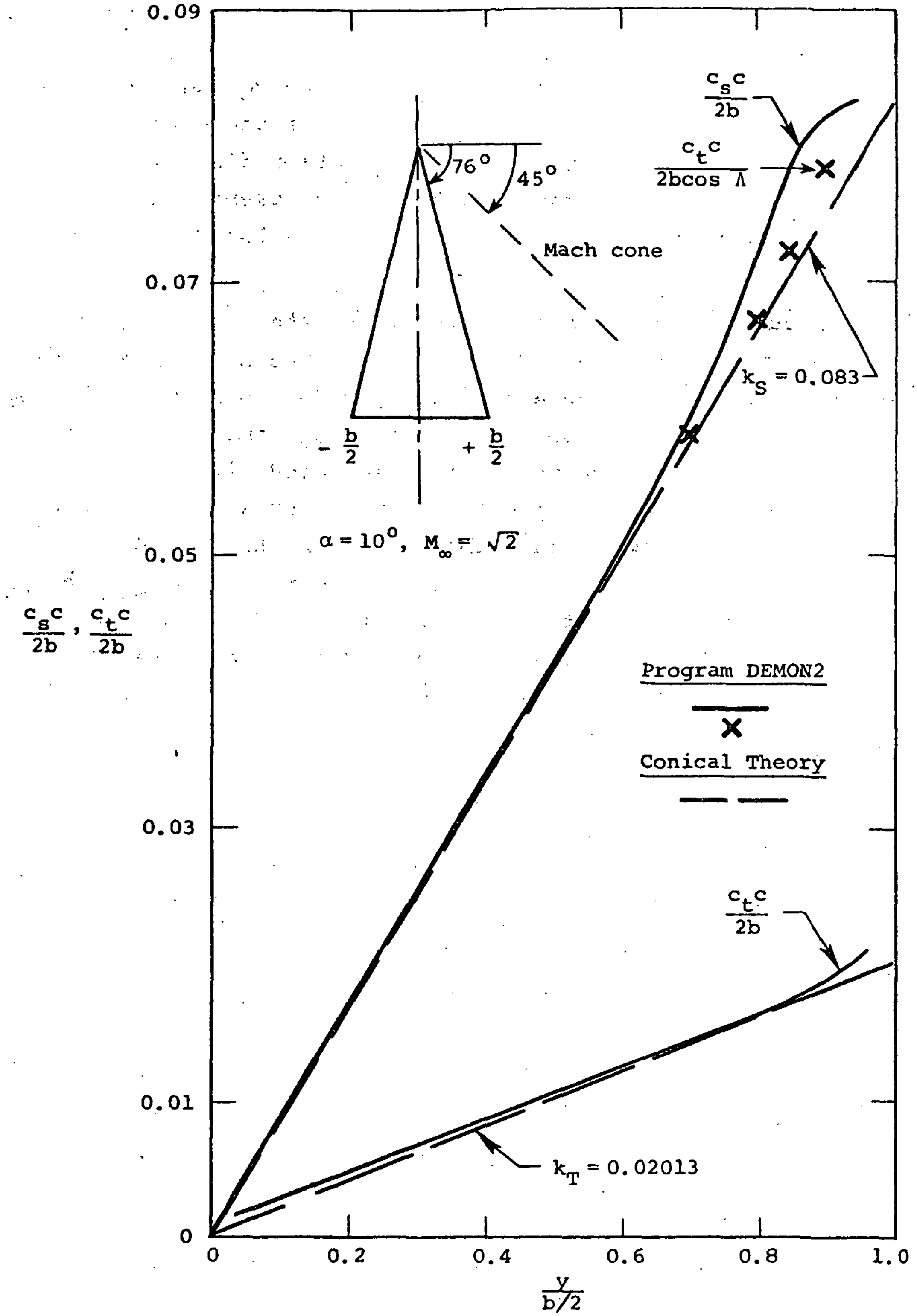


Figure C-1.- Spanload distribution of suction and thrust for a delta wing with aspect ratio 1.

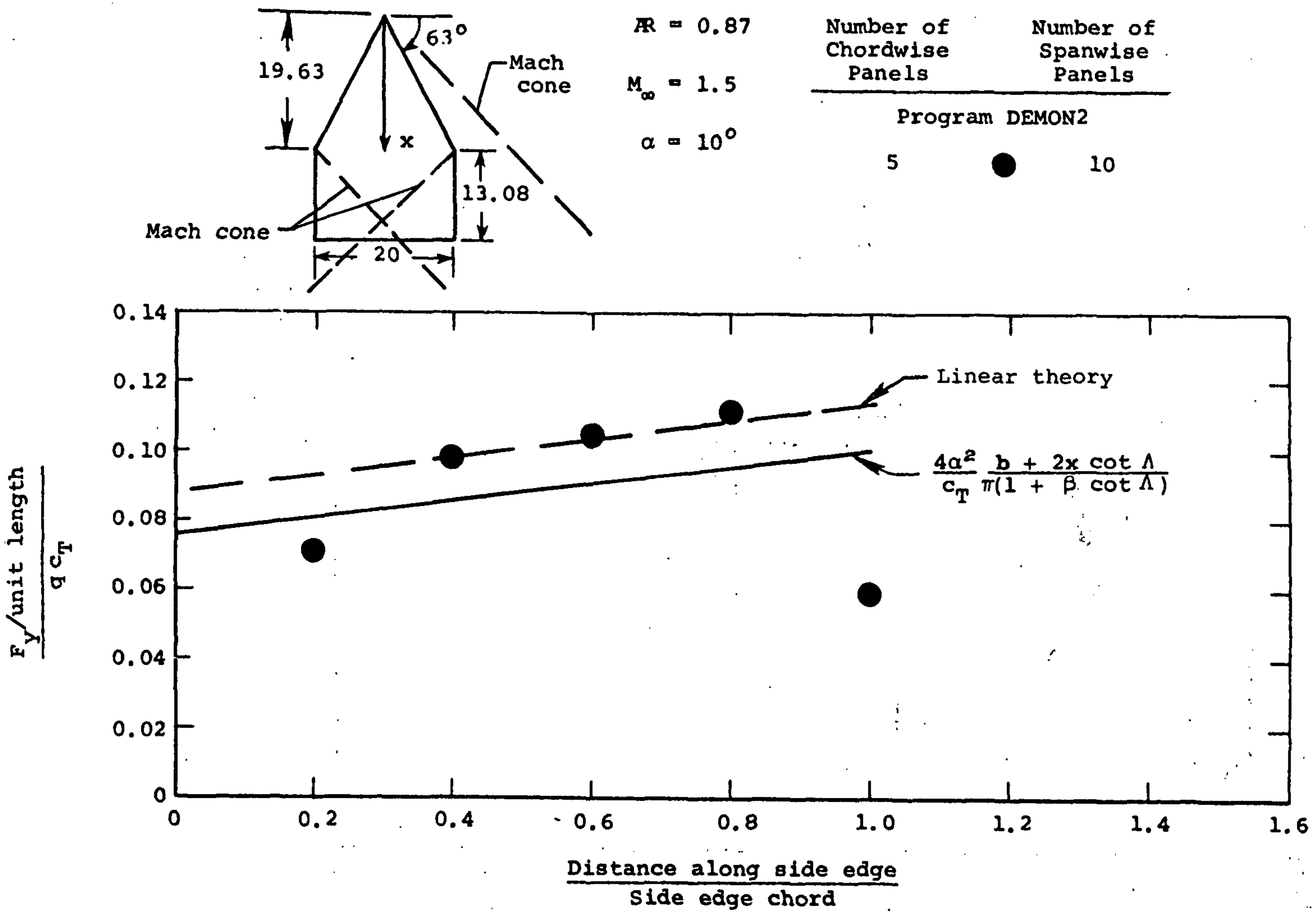


Figure C-2.- Distribution of suction force along side edge of a cropped delta wing; $b = 20$, $c_T = 13.08$, $\Lambda = 63^\circ$.

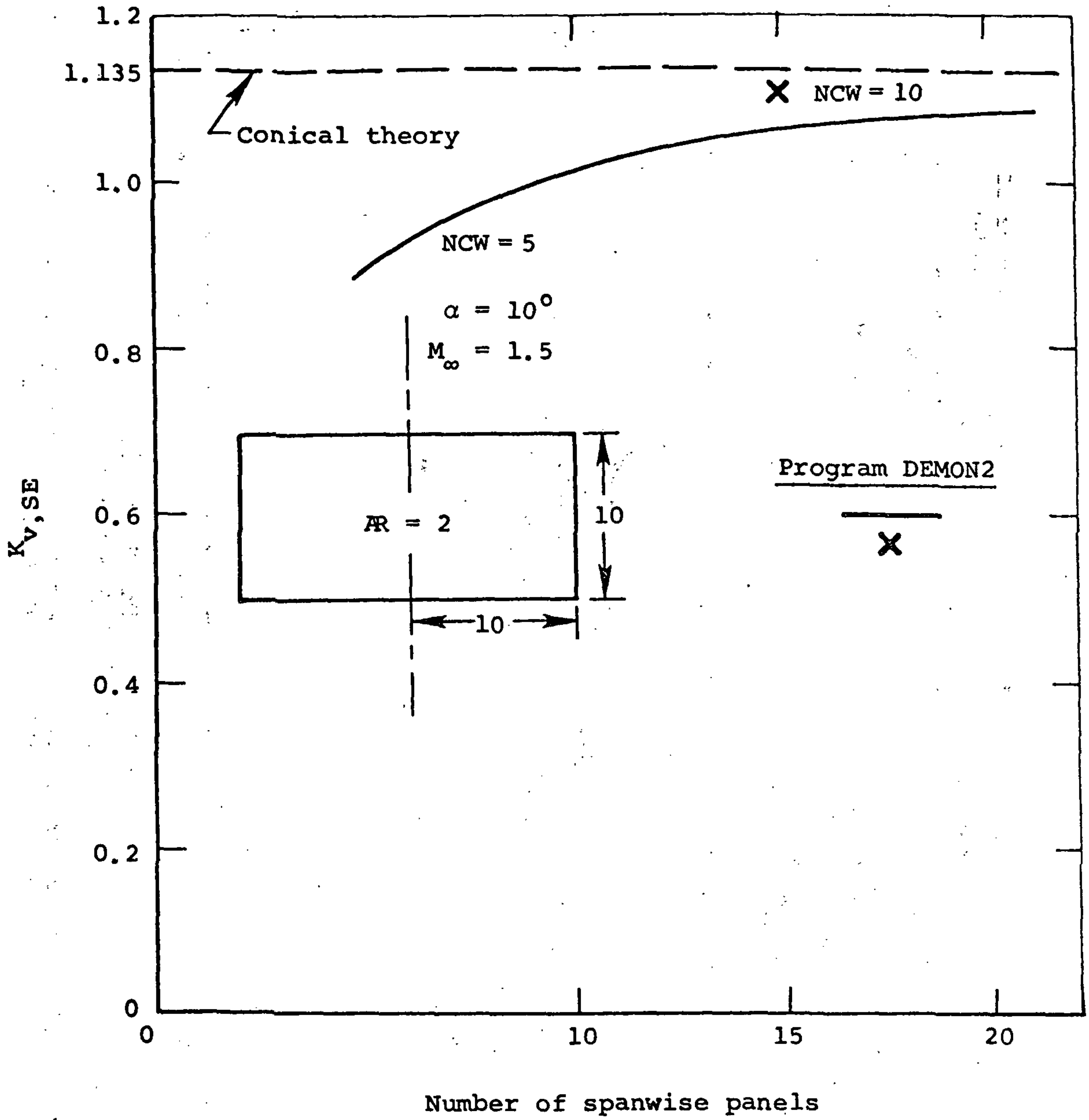
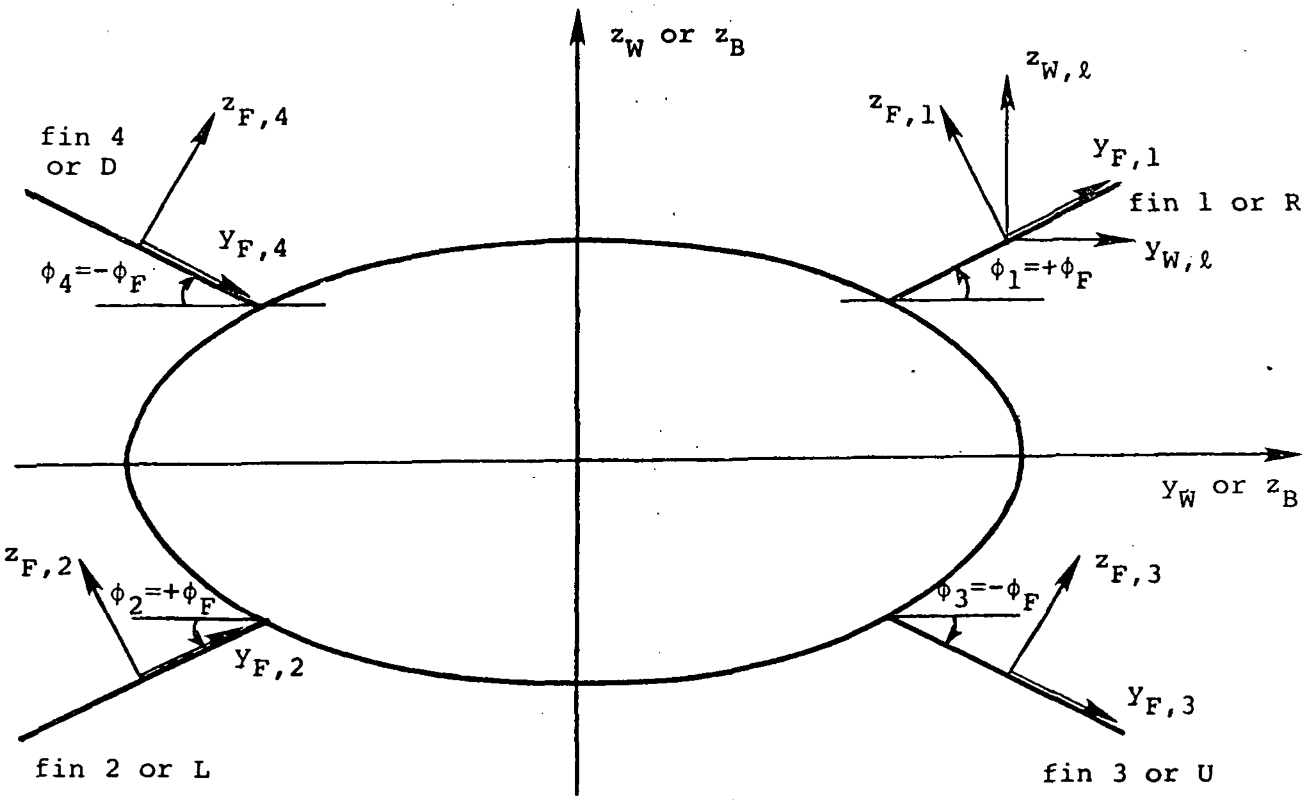


Figure C-3.- Side-edge suction factor $K_{V,SE}$ for a rectangular wing.

APPENDIX D

TRANSFORMATION FROM FIN COORDINATES TO WING OR BODY REFERENCE COORDINATE SYSTEM AND VICE VERSA

In the calculation of the influence of one constant u-velocity panel at the control point of another or at a given field point, the following procedure is used. The coordinates of the four corners of all the constant u-velocity panels are calculated by subroutine LAYOUT in program DEMON2 in the wing coordinate system (x_W, y_W, z_W). The coordinates of the control points (or field points) are also determined by subroutine LAYOUT (or specified) in the wing coordinate system. The first step is to calculate the coordinates of the point relative to the corners of the influencing panel under consideration. Then these local coordinates ($x_{W,\ell}$, $y_{W,\ell}$, $z_{W,\ell}$), which are parallel to the wing coordinate system, are transformed to a panel coordinate system with the y_F and x_F axes in the plane of the fin. In this process the origin at one corner of the constant u-velocity panel remains fixed. Thus, the transformation is a simple rotation through the applicable fin dihedral angle. Only one local coordinate system is shown on each fin in the sketch below.



For the right upper and left lower fins, fin 1 or fin R and fin 2 or fin L, the local wing to local fin coordinate transformation is stated as follows.

$$\left.\begin{aligned} y_{F,1\text{ or }2} &= y_{W,\ell} \cos \phi_{1\text{ or }2} + z_{W,\ell} \sin \phi_{1\text{ or }2} \\ z_{F,1\text{ or }2} &= z_{W,\ell} \cos \phi_{1\text{ or }2} - y_{W,\ell} \sin \phi_{1\text{ or }2} \end{aligned}\right\} \qquad \text{(D1)}$$

Fin dihedral angles ϕ_1 and ϕ_2 are taken equal to the specified fin dihedral angle, $+\phi_F$, also shown in figure 3. The coordinate system rotation for the left upper and right lower fins, fin 4 or fin D and fin 3 or fin U is given by

$$\left.\begin{aligned} y_{F,3\text{ or }4} &= y_{W,\ell} \cos \phi_{3\text{ or }4} - z_{W,\ell} \sin \phi_{3\text{ or }4} \\ z_{F,3\text{ or }4} &= z_{W,\ell} \cos \phi_{3\text{ or }4} + y_{W,\ell} \sin \phi_{3\text{ or }4} \end{aligned}\right\} \qquad \text{(D2)}$$

Fin dihedral angles ϕ_3 and ϕ_4 are taken equal to negative specified fin dihedral angle, $-\phi_F$. Thus, the transformation given by equations (D1) and (D2) are in fact the same provided the negative dihedral angle, $-\phi_F$, associated with fins 3 and 4 is substituted in equation (D1). The local fin to local wing coordinate transformation is given by the following expression. For the right upper and left lower fins, fin 1 or fin R and fin 2 or fin L, the transformation is

$$\left.\begin{aligned} y_{W,\ell} &= y_{F,1\text{ or }2} \cos \phi_{1\text{ or }2} - z_{F,1\text{ or }2} \sin \phi_{1\text{ or }2} \\ z_{W,\ell} &= z_{F,1\text{ or }2} \cos \phi_{1\text{ or }2} + y_{F,1\text{ or }2} \sin \phi_{1\text{ or }2} \end{aligned}\right\} \qquad \text{(D3)}$$

Fin dihedral angles ϕ_1 and ϕ_2 are equal to positive fin dihedral angle, $+\phi_F$. The local fin to local wing coordinate transformation for the left upper and right lower fins, fin 4 or fin D and fin 3 or U can be expressed as

$$\left.\begin{aligned} y_{W,\ell} &= y_{F,3\text{ or }4} \cos \phi_{3\text{ or }4} + z_{F,3\text{ or }4} \sin \phi_{3\text{ or }4} \\ z_{W,\ell} &= z_{F,3\text{ or }4} \cos \phi_{3\text{ or }4} - y_{F,3\text{ or }4} \sin \phi_{3\text{ or }4} \end{aligned}\right\} \qquad \text{(D4)}$$

Fin dihedral angles ϕ_3 and ϕ_4 are equal to negative specified fin dihedral angle, $-\phi_F$. Again, equation (D4) can be obtained from equation (D3) by accounting for the negative dihedral angle, $-\phi_F$, associated with fins 3 and 4.

The transformations indicated by equations (D1) and (D3) are programmed in subroutine ROTATE of program DEMON2. The former is accomplished through entry point ROTWF and the latter through entry point ROTFW in subroutine ROTATE.

The transformation given by equation (D1) also applies to the flow velocity components in the wing coordinate system v_W, w_W aligned with the y_W and z_W axes. After calculating the components v_W and w_W, the velocity components v_F and w_F in the local panel or fin coordinate system can be determined. Conversely, equation (D3) is used to transform velocities in the local panel or fin coordinate system to the local wing coordinate system which is aligned with the reference wing coordinate system (x_W, y_W, z_W). The following appendix concerned with the flow boundary condition makes use of the above equations.

APPENDIX E

INTERDIGITATED FINS, BOUNDARY CONDITIONS

The flow tangency condition states that the net flow velocity normal to the fin must equal zero. Besides the free-stream component, there are external contributions from the body source panels calculated by program WDYBDY and effects induced by vortices associated with the body nose and the monoplane wing calculated by subroutine VVELS in program DEMON2. For all of these external contributions, the coordinate system in which they are expressed is the body or wing reference coordinate system. Body and wing coordinate systems are parallel to one another; see figure 1. The former has its origin at the body nose while the latter has its origin on the body centerline at the axial location of the wing or fin rootchord leading edge. Thus, in order to determine the external contribution to the flow velocity normal to the fin, the components must be resolved and added as follows.

Referring to figure 1, the sidewash, v_W or v_B is aligned with the y_W or y_B axis. Upwash w_W or w_B is in the z_W or z_B direction. The component of the flow normal to the fin surface at the j'th control point ($x_{CPT,j}$, $y_{CPT,j}$, $z_{CPT,j}$) can be determined from the transformations discussed in Appendix D. For example, the normal velocity components on the right upper fin, fin 1 or fin R are obtained from

$$v_{N,j} = w_{W,j} \cos \phi_1 - v_{W,j} \sin \phi_1 \qquad \text{(E1)}$$

In this instance the fin dihedral angle ϕ_1 equals the specified fin dihedral angle ϕ_F listed as PHIDIH in namelist $INPUT of routine CRFWBD in program DEMON2. Angle ϕ_F is also indicated in figure 3. The velocity normal to the left lower fin, fin 2 or fin L is also given by equation (E1) with fin dihedral angle ϕ_2 taken equal to dihedral angle ϕ_F. For the right lower fin, fin 3 or fin U, the velocity normal to the fin surface at the j'th control point is obtained from the velocity components expressed in the wing coordinate system as follows.

$$v_{N,j} = w_{W,j} \cos \phi_3 + v_{W,j} \sin \phi_3 \qquad \text{(E2)}$$

In this equation, angle ϕ_3 is taken equal to negative specified fin dihedral angle, $-\phi_F$. The velocity normal to the left upper fin is also given by equation (E2) substituting angle ϕ_4 for angle ϕ_3. Angle ϕ_4 equals negative fin dihedral angle, $-\phi_F$.

Expressions (E1) and (E2) cause the normal velocity component to be aligned with the direction of the normal load C_N shown in figure 3 for each fin. The contribution from the free stream can be expressed in components directed along the wing or body coordinate system.

$$\left.\begin{aligned} W_W &= V_\infty \sin \alpha \\ V_W &= -V_\infty \sin \beta \end{aligned}\right\} \tag{E3}$$

where α is angle of pitch and β is angle of sideslip. These angles are calculated from the combined angle of attack, α_c, and the angle of roll, ϕ, in accordance with the pitch-roll sequence described in the section entitled GENERAL APPROACH, equation (12).

All external contributions to the normal velocity component are added and substituted directly into equations (E1) and (E2). The sum of all the external contributions to the normal velocity at a control point on a fin must be offset by the sum of the normal velocity components induced by all constant u-velocity panels on the fins and the body interference shell. In computer program DEMON2, the contributions from the constant u-velocity panels on the fins or interference shell are determined in a coordinate system associated with the plane of the panel in question and then transformed to the wing or body coordinate system. Equations (E1) and (E2) together with the transformations discussed in Appendix D are subsequently employed to determine the normal component induced by one panel at the control point of another. The result is a set of simultaneous equations from which the unknown panel strengths can be calculated. Thickness effects from the interdigitated tail fin are not accounted for. For the case of cruciform fins, thickness effects can be accounted for and detailed expressions for the boundary condition are given in section 2 entitled GENERAL APPROACH.

APPENDIX F

INTERDIGITATED FINS, FORCE AND MOMENT CALCULATIONS

The following force- and moment-coefficient calculations are programmed in subroutine LOADS of program DEMON2. Each fin of an interdigitated fin configuration is dealt with separately.

Right upper fin:

Let $C_{N,j}$ be equal to the normal-force coefficient for one constant u-velocity panel with control point coordinates $x_{CPT,j}$, $y_{CPT,j}$ and $z_{CPT,j}$ specified in the wing coordinate system (x_W, y_W, z_W). The positive sense of the normal force is shown in figure 3. Then the components in the positive z_W and y_W or z_B and y_B directions are given by

$$\left.\begin{aligned} C_{Z,j} &= C_{N,j} \cos \phi_F \\ C_{Y,j} &= -C_{N,j} \sin \phi_F \end{aligned}\right\} \tag{F1}$$

in accordance with the rotational coordinate transformation discussed in Appendix D. The pitching moment in the body coordinate system about a specified moment center (XM, 0, ZM) is defined as a moment with its axis normal to the $y_B = 0$ or $y_W = 0$ plane. Clockwise rotation about the y_B or y_W axis when viewing along its positive direction corresponds to positive pitching moment (positive pitching moment causes nose up). For one panel, the contribution to the pitching-moment coefficient is given by

$$C_{m,j} = -C_{z,j} \frac{(x_{CPT,j} - XM)}{\ell_{ref}} \tag{F2}$$

The yawing moment in the body coordinate system about a specified moment center (XM, 0, ZM) is defined as a moment with its axis normal to the $z_B = 0$ or $z_W = 0$ plane. Clockwise rotation about the z_B or z_W axis when viewing along its negative direction corresponds to positive yawing moment (nose to right is positive yawing). The contribution from one panel equals

$$C_{n,j} = -C_{y,j} \frac{(x_{CPT,j} - XM)}{\ell_{ref}} \tag{F3}$$

Rolling moment measured about the body centerline is positive if the right fin(s) move in the clockwise direction viewing upstream. Both components $C_{z,j}$ and $C_{y,j}$ contribute to the rolling-moment coefficient. Thus, the contribution from one panel is

$$C_{\ell,j} = \frac{-C_{z,j}\, y_{CPT,j} + C_{y,j}\, z_{CPT,j}}{\ell_{ref}} \tag{F4}$$

By adding all contributions from the constant u-velocity panels on the right upper fin, the total force and moment coefficients acting on that fin can be determined. Thus for the upper right fin designated Fin 1 or Fin R, the forces acting on it in the z_W and y_W directions, respectively, are given in coefficient form as

$$\left.\begin{aligned} C_{z,1} \text{ or } C_{z,R} &= \sum_{j=1}^{NRP} C_{N,j} \cos\phi_F \\ C_{y,1} \text{ or } C_{y,R} &= -\sum_{j=1}^{NRP} C_{N,j} \sin\phi_F \end{aligned}\right\} \tag{F5}$$

Here NRP is the number of constant u-velocity panels on the right upper fin. The pitching-, yawing- and rolling-moment coefficients are obtained from the following expressions, respectively.

$$\left.\begin{aligned} C_{m,1} \text{ or } C_{m,R} &= -\sum_{j=1}^{NRP} C_{N,j} \cos\phi_F \frac{(x_{CPT,j} - XM)}{\ell_{ref}} \\ C_{n,1} \text{ or } C_{n,R} &= \sum_{j=1}^{NRP} C_{N,j} \sin\phi_F \frac{(x_{CPT,j} - XM)}{\ell_{ref}} \\ C_{\ell,1} \text{ or } C_{\ell,R} &= -\sum_{j-1}^{NRP} \frac{(C_{N,j} \cos\phi_F y_{CPT,j} - C_{N,j} \sin\phi_F (z_{CPT,j} - ZM))}{\ell_{ref}} \end{aligned}\right\} \tag{F6}$$

The reference length ℓ_{ref} as well as the reference area S_{ref} are specified in namelist INPUT of routine CRFWBD in program DEMON2 as REFL and SREF, respectively. Fin dihedral angle, ϕ_1 or ϕ_R, is defined as shown in figure 3 and equals positive angle ϕ_F. Angles ϕ_F and θ are specified in namelist $INPUT in the main program CRFWBD of program DEMON2 as PHIDIH and THETIT, respectively.

<u>Left lower fin</u>:

All expressions shown and discussed above for the right upper fin apply except for equation (E5) which gives the forces acting on the left lower fin. They are changed to

$$\left.\begin{aligned} C_{z,2} \text{ or } C_{z,L} &= \sum_{j=NRP+1}^{NHP} C_{N,j} \cos\phi_F \\ C_{y,2} \text{ or } C_{y,L} &= -\sum_{j=NRP+1}^{NHP} C_{N,j} \sin\phi_F \end{aligned}\right\} \qquad \text{(F7)}$$

where NHP is the number of constant u-velocity panels on the right upper fin plus the number of panels on the lower left fin. Likewise, the expressions (F6) for moments become

$$\left.\begin{aligned} C_{m,2} \text{ or } C_{m,L} &= -\sum_{j=NRP+1}^{NHP} C_{N,j} \cos\phi_F \frac{(x_{CPT,j}-XM)}{\ell_{ref}} \\ C_{n,2} \text{ or } C_{n,L} &= \sum_{j=NRP+1}^{NHP} C_{N,j} \sin\phi_F \frac{(x_{CPT,j}-XM)}{\ell_{ref}} \\ C_{\ell,2} \text{ or } C_{\ell,L} &= -\sum_{j=NRP+1}^{NHP} \frac{(C_{N,j}\cos\phi_F\, y_{CPT,j} - C_{N,j}\sin\phi_F\,(z_{CPT,j}-ZM))}{\ell_{ref}} \end{aligned}\right\} \qquad \text{(F8)}$$

Note that in accordance with the convention indicated in figure 3, the dihedral angle, ϕ_2 or ϕ_L, associated with this fin equals positive angle ϕ_F. Fin location angle, $\theta_{2 \text{ or } L}$, is defined as shown and equals positive angle θ.

Right lower fin:

Referring again to figure 3, the dihedral angle of this fin, ϕ_3 or ϕ_U, equals the negative angle, $-\phi_F$. The positive sense of C_N is also indicated. For this fin, the fin location angle, θ_3 or θ_U, equals the negative angle, $-\theta$. All expressions shown and discussed above for the right upper fin apply except equations (F5) and (F6) for which the index of the summations is changed and also accounting for the change in sign on terms involving dihedral angle ϕ_F.

$$\left.\begin{aligned} C_{Z,3} \text{ or } C_{Z,U} &= \sum_{j=NHP+1}^{N3P} C_{N,j} \cos \phi_F \\ C_{Y,3} \text{ or } C_{Y,U} &= \sum_{j=NHP+1}^{N3P} C_{N,j} \sin \phi_F \end{aligned}\right\} \qquad \text{(F9)}$$

where N3P equals the number of constant u-velocity panels on the right upper fin added to the number on the left lower fin added to the number on the lower right fin. The pitching-, yawing- and rolling-moment coefficients are

$$\left.\begin{aligned} C_{m,3} \text{ or } C_{m,U} &= -\sum_{j=NHP+1}^{N3P} C_{N,j} \cos \phi_F \frac{(x_{CPT,j}-XM)}{\ell_{ref}} \\ C_{n,3} \text{ or } C_{n,U} &= -\sum_{j=NHP+1}^{N3P} C_{N,j} \sin \phi_F \frac{(x_{CPT,j}-XM)}{\ell_{ref}} \\ C_{\ell,3} \text{ or } C_{\ell,U} &= -\sum_{j=NHP+1}^{N3P} \frac{(C_{N,j} \cos\phi_F \, Y_{CPT,j} - C_{N,j} \sin\phi_F \, (z_{CPT,j}-ZM))}{\ell_{ref}} \end{aligned}\right\} \qquad \text{(F10)}$$

Left upper fin:

The dihedral angle for this fin, ϕ_4 or ϕ_D, and its location angle, θ_4 or θ_D, have the same sense as those for the right lower fin. Thus, ϕ_4 equals negative angle, $-\phi_F$, and ϕ_4 equals negative angle, $-\theta$. The expressions for the forces and moments acting on this fin are the same as equations (E5) and (E6) except for a change in the index and accounting for the change in sign for terms involving ϕ_F.

$$\left.\begin{aligned} C_{Z,4} \text{ or } C_{Z,D} &= \sum_{j=N3P+1}^{NPANLS} C_{N,j} \cos \phi_F \\ C_{Y,4} \text{ or } C_{Y,D} &= \sum_{j=N3P+1}^{NPANLS} C_{N,j} \sin \phi_F \end{aligned}\right\} \tag{F11}$$

Here, NPANLS equals the sum of the number of constant u-velocity panels on all four fins. The pitching-, yawing- and rolling-moment coefficients are given by

$$\left.\begin{aligned} C_{m,4} \text{ or } C_{m,D} &= -\sum_{j=NHP+1}^{NPANLS} C_{N,j} \cos \phi_F \frac{(x_{CPT,j}-XM)}{\ell_{ref}} \\ C_{n,4} \text{ or } C_{n,D} &= -\sum_{j=NHP+1}^{NPANLS} C_{N,j} \sin \phi_F \frac{(x_{CPT,j}-XM)}{\ell_{ref}} \\ C_{\ell,4} \text{ or } C_{\ell,D} &= -\sum_{j=NHP+1}^{NPANLS} \frac{(C_{N,j} \cos\phi_F \, y_{CPT,j} - C_{N,j} \sin\phi_F \, (z_{CPT,j}-ZM))}{\ell_{ref}} \end{aligned}\right\} \tag{F12}$$

If the aerodynamic loading is symmetric about the vertical or $y_B = 0$ plane as is the case for an unrolled configuration with symmetric body nose vorticity, only the right upper and lower fins are considered and the overall sideforce, C_y, and yawing moment, C_n, are zero.

APPENDIX G

BODY INTERFERENCE PANELS IN SHELL OF ELLIPTICAL CROSS SECTION, FORCE AND MOMENT CALCULATIONS

The following force and moment coefficients are computed in subroutine LOADS of program DEMON2. Let $C_{N,k}$ be equal to the normal-force coefficient for one body interference panel (a constant u-velocity panel) with control point coordinates $x_{CPT,k}$, $y_{CPT,k}$, $z_{CPT,k}$ specified in the wing coordinate system (x_W, y_W, z_W). The positive sense of the normal force corresponds to a force pointing outward from the body as shown in figure 3. The components in the z_W and y_W or z_B and y_B direction are given by

$$\left.\begin{aligned} C_{z,k} &= C_{N,k} \cos \theta_{2_k} \\ C_{y,k} &= C_{N,k} \sin \theta_{2_k} \end{aligned}\right\} \tag{G1}$$

when θ_2 is the angle between the panel trailing edge and the y_W axis. It is calculated in accordance with

$$\left.\begin{aligned} \sin \theta_{2_k} &= \frac{z_{W_{k,i}} - z_{W_{k,i-1}}}{\left[\left(z_{W_{k,i}} - z_{W_{k,i-1}}\right)^2 + \left(y_{W_{k,i}} - y_{W_{k,i-1}}\right)^2\right]^{\frac{1}{2}}} \\ \cos \theta_{2_k} &= -\frac{y_{W_{k,i}} - y_{W_{k,i-1}}}{\left[\left(z_{W_{k,i}} - z_{W_{k,i-1}}\right)^2 + \left(y_{W_{k,i}} - y_{W_{k,i-1}}\right)^2\right]^{\frac{1}{2}}} \end{aligned}\right\} \tag{G2}$$

Subscript i and i-1 refer to the two parallel panel side edges as shown in figure 3. Note that panel location angle θ_{BIP} positions the side edge designated i on the body circumference (BIP stands for body interference panel).

For the k'th body interference panel, the contribution to the pitching-moment coefficient is taken about moment center (XM, 0, ZM) and is given by

$$C_{m,k} = -C_{z,k} \frac{x_{CPT,k} - XM}{\ell_{ref}} \tag{G3}$$

where as discussed earlier in connection with the right upper fin, positive pitching corresponds to nose-up motion. The contribution to the yawing-moment coefficient from the k'th body interference panel equals

$$C_{n,k} = -C_{y,k} \frac{x_{CPT,k} - XM}{\ell_{ref}} \tag{G4}$$

where positive yawing corresponds to nose to right motion. As is the case for the interdigitated fins, both components of the normal-force coefficient contribute to the rolling-moment coefficient.

$$C_{\ell,k} = \frac{-C_{z,k}\, y_{CPT,k} + C_{y,k}(z_{CPT,k} - ZM)}{\ell_{ref}} \tag{G5}$$

By adding all contributions from all the constant u-velocity panels laid out on the interference shell, the total force and moment coefficients acting on the part of the body covered by the interference shell can be calculated. Thus, the contributions to the overall forces acting in the z_W and y_W directions are given in coefficient form as

$$\left.\begin{aligned} C_{z,BIP} &= \sum_{k=1}^{NBIP} C_{N,k} \cos \theta_{2_k} \\ C_{y,BIP} &= \sum_{k=1}^{NBIP} C_{N,k} \sin \theta_{2_k} \end{aligned}\right\} \tag{G6}$$

Here, the number of constant u-velocity panels in the interference shell if given by NBIP. The contributions to the overall pitching-, yawing- and rolling-moment coefficients are specified as follows, respectively.

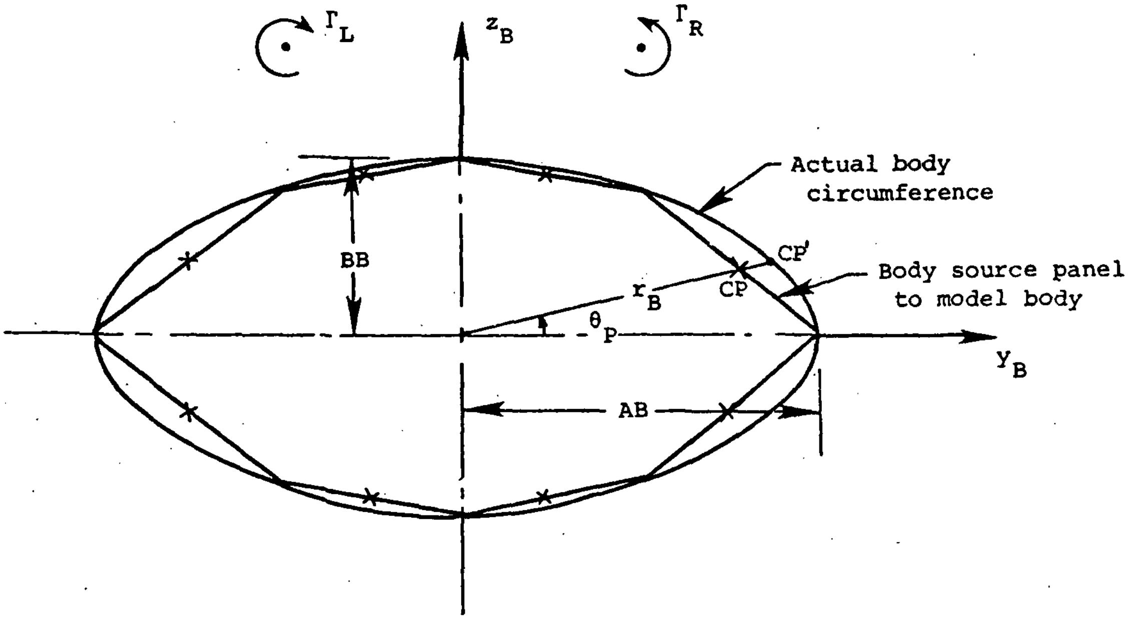
$$\left.\begin{aligned}
C_{m,BIP} &= -\sum_{k=1}^{NBIP} C_{N,k} \cos\theta_{2_k} \frac{x_{CPT,k}-XM}{\ell_{ref}} \\
C_{n,BIP} &= -\sum_{k=1}^{NBIP} C_{N,k} \sin\theta_{2_k} \frac{x_{CPT,k}-XM}{\ell_{ref}} \\
C_{\ell,BIP} &= -\sum_{k=1}^{NBIP} \frac{C_{N,k}\cos\theta_{2_k} y_{CPT,k} - C_{N,k}\sin\theta_{2_k}(Z_{CPT,k}-ZM)}{\ell_{ref}}
\end{aligned}\right\} \tag{G7}$$

As mentioned earlier, the reference length ℓ_{ref} and the reference area S_{ref} are specified in namelist $INPUT of routine CRFWBD in program DEMON2 as REFL and SREF, respectively.

APPENDIX H

EFFECTS OF EXTERNAL VORTICITY ON BODY WITH ELLIPTICAL CROSS SECTION

The sketch below shows the circumference of an elliptical body. Also indicated are eight panels in end view as an example of a sparse body paneling layout. The panels can be source panels as employed in program WDYBDY to account for body volume, angle of pitch and angle of sideslip. However, in program DEMON2, these panels are constant u-velocity panels to account for wing-body or tail fin-body interference. In either case, the panel control points designated CP in the sketch lie inside the actual body circumference. In the calculation of pressure distribution on the body, it is desired to account for external vortices at the control points. Let Γ_R and Γ_L be body nose vorticity idealized to two potential flow vortices.



The solution for the flow field around a body with elliptical cross section in the presence of specified external vortices is given in Appendix I. This solution is programmed in subroutine VVELS in both programs WDYBDY and DEMON2 and provides valid flow field velocities at points on and outside the body circumference. However, the control points, CP, are inside the body by virtue of the method resulting in a layout of inscribed panels. For the purpose of accounting for the presence of the vortices, their induced velocities are calculated at points CP' instead. They lie on the intersection of the body radius which contains control point CP and the body circumference. In actuality, points CP' are displaced further out a distance equal to one percent of the body radius r_B in the programs using subroutine VVELS. This is done to prevent numerical problems encountered when computing velocities on the body surface if the coordinates of the body points are calculated and specified to subroutine VVELS. To accomplish this, the polar angle θ_P designated THETP in the computer program is calculated first as follows.

$$\theta_P = \tan^{-1} \frac{z_{CPT}}{y_{CPT}} \tag{H1}$$

The coordinates of a given control point CP are x_{CPT}, y_{CPT} and z_{CPT} in either the body or wing reference coordinate system. Then to determine the body radius r_B at angle θ_P, the equation for the ellipse is used.

$$r_B^2 = \frac{1}{\dfrac{\cos^2\theta_P}{AB^2} + \dfrac{\sin^2\theta_P}{BB^2}} \tag{H2}$$

Here AB is the horizontal semi-axis and BB is the vertical semi-axis of the elliptical cross section for given axial body station. The coordinates of the corresponding body surface point CP' displaced one percent of the radius r_B outside the actual body circumference are

$$\begin{aligned} y_{CPB} &= 1.01 r_B \cos\theta_P \\ z_{CPB} &= 1.01 r_B \sin\theta_P \end{aligned} \tag{H3}$$

Thus, subroutine VVELS computes the vortex induced velocities at points CP'. These velocities are added to all other velocity component contributions calculated at the panel control points, CP. The pressure is then calculated at points CP in accordance with the Bernoulli relation, equation (10).

APPENDIX I

VELOCITY COMPONENTS IN CROSSFLOW PLANE REQUIRED TO CALCULATE VORTEX TRAJECTORIES

In order to calculate vortex trajectories using slender-body methods, it is necessary to know the two velocity components in the crossflow plane at the vortices. The lateral movement between two axial stations a distance Δx apart can be calculated from these quantities. Since a number of different cross sectional shapes in the crossflow planes are of interest in the present computer program, a number of different solutions are needed. Specifically the following eight velocity fields are used.

1. Velocity field induced in crossflow plane by a set of vortices in the presence of a cruciform wing-body combination on one member of the set.

2. Velocity components in crossflow plane due to pitch and bank of a cruciform wing-body combination including volume effects.

3. Flow field in crossflow plane due to symmetrical deflection of two panels of a planar wing-body combination.

4. Flow field in crossflow plane due to deflection of a single panel on a cruciform wing-body combination.

5. Velocities on a vortex due to other vortices in the crossflow plane in the presence of a monoplane midwing mounted on a body of elliptical cross-section.

6. Velocity components in crossflow plane due to pitch and bank of a monoplane midwing mounted on a body of elliptical cross-section.

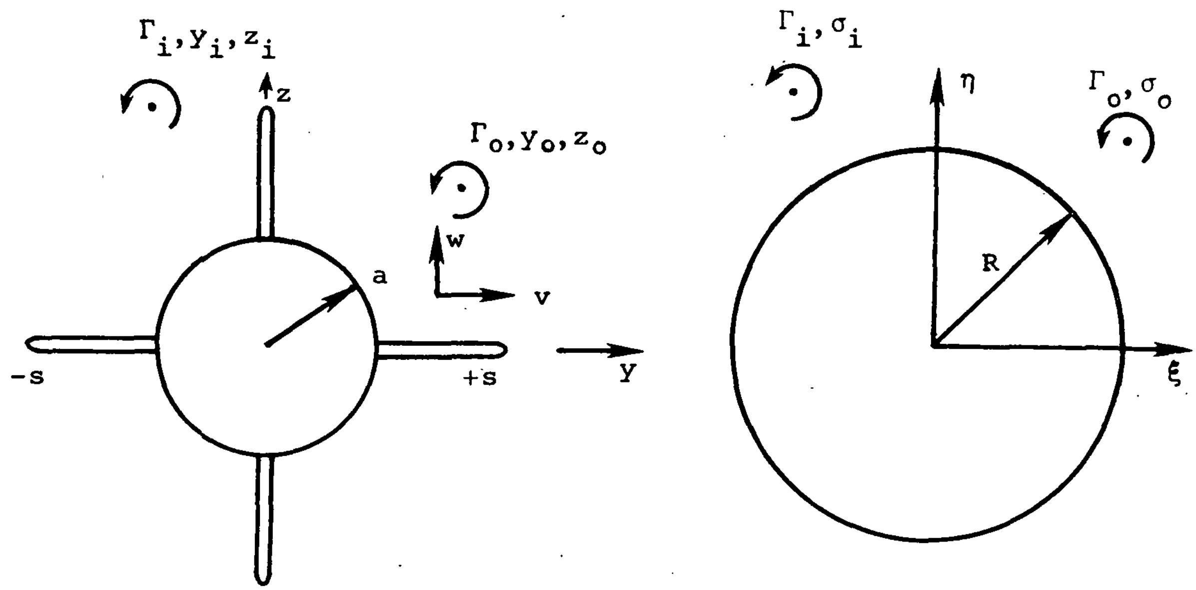
7. Velocities on a vortex due to other vortices in the presence of a monoplane midwing mounted on a body of elliptical cross-section including effects of angles of pitch and sideslip.

8. Velocity components in the crossflow plane due to expansion of a body with elliptical cross sections.

The expressions for all these velocity fields are given in this Appendix. Although some of the expressions have been published elsewhere, they are all being presented here for completeness and to collect the results in one place.

1.- Velocity Field Induced in Crossflow Plane by a Set of Vortices in the Presence of a Cruciform Wing-Body Combination on One Member of the Set

This solution is required to determine the trajectory of a vortex in the presence of a cruciform wing-body combination. The solution for v and w will be determined using slender-body theory. The following transformation of a cruciform wing-body into a circle of radius R is used.



$\tau = y + iz$ $\qquad\qquad$ $\sigma = \xi + i\eta$

$$\tau^2 + \frac{a^4}{\tau^2} = \sigma^2 + \frac{R^4}{\sigma^2} \qquad 2R^2 = s^2 + \frac{a^4}{s^2} \tag{I1}$$

$$\sigma = \frac{1}{2}\left[\sqrt{\left(\tau^2 + \frac{a^4}{\tau^2}\right)^2 - 2R^2} + \sqrt{\left(\tau^2 + \frac{R^4}{\tau^2}\right) + 2R^2}\right] \tag{I2}$$

$$\tau = \frac{1}{2}\left[\sqrt{\left(\sigma^2 + \frac{R^4}{\sigma^2}\right)^2 - 2a^2} + \sqrt{\left(\sigma^2 + \frac{R^4}{2}\right) + 2R^2}\right] \tag{I3}$$

The potential for one vortex in the presence of the circle in the σ plane is

$$W_1(\sigma) = \frac{-i\Gamma_o}{2\pi}\,\ell n\,(\sigma-\sigma_o) + \frac{i\Gamma_o}{2\pi}\,\ell n\left(\sigma - \frac{R^2}{\bar{\sigma}_o}\right) \tag{I4}$$

We omit center vortices to keep the solution regular for large σ. The complex potential for the set of vortices is

$$W_t(\sigma) = \frac{-i\Gamma_o}{2\pi} \ell n\ (\sigma-\sigma_o) + \frac{i\Gamma_o}{2\pi} \ell n \left(\sigma - \frac{R^2}{\bar{\sigma}_o}\right) - \frac{i}{2\pi} \sum_{i=1}^{N} \Gamma_i\ \ell n \left[\frac{\sigma - \sigma_i}{\left(\sigma - \frac{R^2}{\bar{\sigma}_i}\right)}\right] \tag{I5}$$

The complex potential in the τ plane is given by equation (I5) with the substitution $\sigma = \sigma(\tau)$.

Consider now the complex potential for the motion of vortex Γ_o in the τ plane.

$$W_{\Gamma_o}(\tau) = W_t(\sigma(\tau)) + \frac{i\Gamma_o}{2\pi} \ell n(\tau - \tau_o) \tag{I6}$$

The velocity components of Γ_o in the τ plane are

$$v_o - iw_o = \frac{d}{d\tau} W_{\Gamma_o}(\tau)\Big|_{\tau=\tau_o} \tag{I7}$$

$$\frac{d}{d\tau} W_{\Gamma_o}(\tau) = \frac{d}{d\tau}\left[\frac{-i\Gamma_o}{2\pi} \ell n \left(\frac{\sigma-\sigma_o}{\tau-\tau_o}\right)\right] + \frac{d}{d\tau}\left[\frac{i\Gamma_o}{2\pi} \ell n \left(\sigma - \frac{R^2}{\bar{\sigma}_o}\right)\right] - \frac{i}{2\pi} \frac{d}{d\tau} \sum \Gamma_i\ \ell n \left[\frac{\sigma - \sigma_i}{\sigma - \frac{R^2}{\bar{\sigma}_i}}\right] \tag{I8}$$

It is shown (ref. 4) that

$$\frac{d}{d\tau} \ell n \left(\frac{\tau-\tau_o}{\sigma-\sigma_o}\right)\Big|_{\tau\to\tau_o} = \lim_{\tau\to\tau_o} \left[\frac{1}{\tau-\tau_o} - \frac{1}{(\sigma-\sigma_o)} \frac{d\sigma}{d\tau}\right]$$

$$\sigma-\sigma_o = (\tau-\tau_o)\left(\frac{d\sigma}{d\tau}\right)_{\tau_o} + \frac{1}{2}(\tau-\tau_o)^2 \frac{d^2\sigma}{d\tau^2}\Big|_{\tau_o}$$

$$\frac{d\sigma}{d\tau} = \left(\frac{d\sigma}{d\tau}\right)_{\tau_o} + (\tau-\tau_o) \frac{d^2\sigma}{d\tau^2}\Big|_{\tau_o} \tag{I9}$$

$$\frac{1}{\tau-\tau_o} - \frac{1}{(\sigma-\sigma_o)}\frac{d\sigma}{d\tau} = \frac{1}{\sigma-\sigma_o}\left(\frac{\sigma-\sigma_o}{\tau-\tau_o} - \frac{d\sigma}{d\tau}\right)$$

$$= \frac{1}{\sigma-\sigma_o}\left[\left(\frac{d\sigma}{d\tau}\right)_{\tau_o} + \frac{1}{2}(\tau-\tau_o)\left.\frac{d^2\sigma}{d\tau^2}\right|_{\tau_o}\right.$$

$$\left. - \left.\frac{d\sigma}{d\tau}\right|_{\tau_o} - (\tau-\tau_o)\left.\frac{d^2\sigma}{d\tau^2}\right|_{\tau_o} \cdots\right]$$

$$= -\frac{1}{2}\left(\frac{\tau-\tau_o}{\sigma-\sigma_o}\right)\left.\frac{d^2\sigma}{d\tau^2}\right|_{\tau_o} \tag{I10}$$

$$\lim_{\tau\to\tau_o}\left(\frac{d}{d\tau}\right)\left[\ln\left(\frac{\tau-\tau_o}{\sigma-\sigma_o}\right)\right] = -\frac{1}{2}\left(\frac{d\tau}{d\sigma}\right)_{\tau_o}\left(\frac{d^2\sigma}{d\tau^2}\right)_{\tau_o} \tag{I11}$$

$$v_o - iw_o = \frac{i\Gamma_o}{2\pi}\left[-\frac{1}{2}\left(\frac{d\tau}{d\sigma}\right)\frac{d^2\sigma}{d\tau^2}\right]_{\tau_o} + \frac{i\Gamma_o}{2\pi}\frac{\bar{\sigma}_o}{\sigma_o\bar{\sigma}_o - R^2}\left(\frac{d\sigma}{d\tau}\right)_{\tau_o}$$

$$- \frac{i}{2\pi}\sum_{i=1}^{N}\Gamma_i\left(\frac{1}{\sigma_o - \sigma_i} - \frac{\bar{\sigma}_i}{\sigma_o\bar{\sigma}_i - R^2}\right)\left(\frac{d\sigma}{d\tau}\right)_{\tau_o} \tag{I12}$$

$$\frac{d\sigma}{d\tau} = \frac{\frac{1}{2}\left(\tau^3 - \frac{a^4}{\tau}\right)\left[\sqrt{\left(\tau^2 + \frac{a^4}{\tau^2}\right) + 2R^2} + \sqrt{\left(\tau^2 + \frac{a^4}{\tau^2}\right) - 2R^2}\right]}{\sqrt{\left(\tau^2 + \frac{a^4}{\tau^2}\right)^2 - 4R^4}} \tag{I13}$$

Equations (I1), (I2) and (I3) yield the following relationships.

$$\frac{d\sigma}{d\tau} = \frac{(\tau^4 - a^4)\sigma^3}{\tau^3(\sigma^4 - R^4)} \tag{I14}$$

$$\frac{d^2\sigma}{d\tau^2} = \frac{\sigma^3(\tau^4 + 3a^4)}{(\sigma^4 - R^4)\tau^4} - \frac{\sigma^5(\tau^4 - a^4)^2(\sigma^4 + 3R^4)}{\tau^6(\sigma^4 - R^4)^3} \tag{I15}$$

$$\frac{d\tau}{d\sigma}\frac{d^2\sigma}{d\tau^2} = \frac{\tau^2(\sigma^4 - R^4)^2(\tau^4 + 3a^4) - \sigma^2(\tau^4 - a^4)^2(\sigma^4 + 3R^4)}{\tau^3(\sigma^4 - R^4)^2(\tau^4 - a^4)} \tag{I16}$$

With these results, we find the desired velocity

$$v_o - iw_o = \frac{-i\Gamma_o}{4\pi} \frac{\left[\tau_o^2\left(\sigma_o^4 - R_o^4\right)^2\left(\tau^4 + 3a^4\right) - \sigma_o^2\left(\tau_o^4 - a^4\right)^2\left(\sigma_o^4 + 3R^4\right)\right]}{\tau_o^3\left(\sigma_o^4 - R^4\right)^2\left(\tau_o^4 - a^4\right)}$$

$$+ \frac{i\Gamma_o}{2\pi} \frac{\bar{\sigma}_o}{\left(\sigma_o\bar{\sigma}_o - R^2\right)} \frac{\left(\tau_o^4 - a^4\right)\sigma_o^3}{\tau_o^3\left(\sigma_o^4 - R^4\right)}$$

$$- \frac{i}{2\pi} \frac{(\tau_o^4 - a^4)(\sigma_o^3)}{\tau_o^3\left(\sigma_o^4 - R^4\right)} \sum_{i=1}^{N} \Gamma_i \left[\frac{1}{\sigma_o - \sigma_i} - \frac{\bar{\sigma}_i}{\sigma_o\bar{\sigma}_i - R^2}\right] \tag{I17}$$

where

Γ_o = strength of vortex, the velocity components of which are being calculated

v_o, w_o = velocity component of vortex Γ_o

Γ_i = strength of any vortex except Γ_o; $i=1,2,\ldots N$

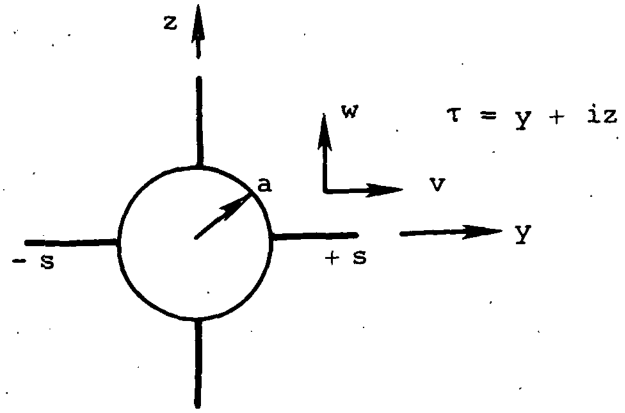
τ_o = position of Γ_o in τ plane

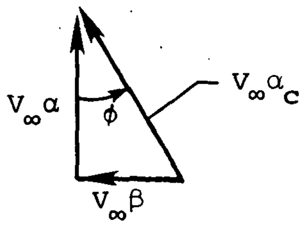
σ_o = position of Γ_o in σ plane

σ_i = position of Γ_i in σ plane

2.- Velocity Components in Crossflow Plane Due to Pitch and Bank of a Cruciform Wing-Body Combination Including Volume Effects

For a pitched and banked cruciform missile the induced flow field can be obtained by superimposing two planar missile flow fields at right angles





APPENDIX I

The flow field about a planar wing-body with horizontal wings is described by complex potential W_α corresponding to $V_\infty \cos\phi \sin\alpha_c$ along the positive axis of z. The complex potential W_β is associated with velocity $-V_\infty \sin\phi \sin\alpha_c$ along the negative axis of y. The total potential is then

$$\frac{W(\tau)}{V_\infty} = b_o(x) + a\left(\frac{da}{dx}\right) \ln\tau + W_\alpha(\tau) + W_\beta(\tau) \tag{I18}$$

If $\phi = 0$, the perturbation complex potential is given in equation 5.3 of reference 8. Using the small angle approximation:

$$\frac{W(\tau)}{V_\infty} = b_o(x) + a\left(\frac{da}{dx}\right) \ln\tau - i\alpha\left\{\left[\left(\tau + \frac{a^2}{\tau}\right)^2 - \left(s + \frac{a^2}{s}\right)^2\right]^{\frac{1}{2}} - \tau\right\} \tag{I19}$$

The velocity v-iw for $\phi = 0$ is then

$$\frac{v-iw}{V_\infty} = \frac{1}{V_\infty}\frac{dW}{d\tau} = a\left(\frac{da}{dx}\right)\frac{1}{\tau} + i\alpha$$

$$\frac{-i\alpha\,(\tau^4-a^4)s}{\tau^2\sqrt{\left(\tau^2 - s^2\right)\left(\tau^2 s^2 - a^4\right)}}\;;\; \phi = 0 \tag{I20}$$

and

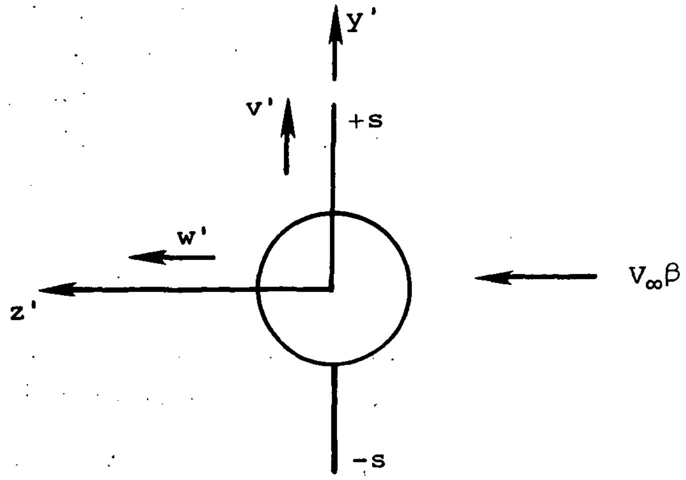
$$v-iw \rightarrow 0 \quad \text{as} \quad \tau \rightarrow \infty$$

The perturbation velocity $v_\infty - iw_\alpha$ associated with the velocity component $V_\infty\alpha$ is

$$\frac{v_\alpha - iw_\alpha}{V_\infty} = \frac{-i\alpha\,(\tau^4-a^4)s}{\tau^2\sqrt{\left(\tau^2 - s^2\right)\left(\tau^2 s^2 - a^4\right)}} + i\alpha \tag{I21}$$

From this expression we can determine the perturbation velocity $v_\beta - iw_\beta$ associated with the velocity $V_\infty\beta$ along the negative axis of y.

Consider a set of coordinates y' and z' as shown with velocity components v' and w' with $\tau' = -i\tau$.



The perturbation velocity v'-iw' is given analogous to equation (I21) as

$$\frac{v'-iw'}{V_\infty} = \frac{-i\beta\,(\tau'^4 - a^4)s}{\tau'^2\sqrt{\left(\tau'^2 - s^2\right)\left(\tau'^2 s^2 - a^4\right)}} + i\beta$$

$$= \frac{-i\beta\,(\tau^4 - a^4)s}{\tau^2\sqrt{\left(\tau^2 + s^2\right)\left(\tau^2 s^2 + a^4\right)}} + i\beta \qquad \text{(I22)}$$

$$-i(v'-iw') = v_\beta - iw_\beta = \frac{-\beta\,(\tau^4 - a^4)s}{\tau^2\sqrt{\left(\tau^2 + s^2\right)\left(\tau^2 s^2 + a^4\right)}} + \beta \qquad \text{(I23)}$$

It is possible to add $v_\beta - iw_\beta$ to the results of equation (I20) for $\phi = 0$ to obtain the total complex potential for the cruciform wing-body combination since the sum satisfies the boundary condition. Accordingly we have the final result

$$v-iw = a\left(\frac{da}{dx}\right)\left(\frac{1}{\tau}\right) + i\alpha + \beta - \frac{i\alpha\,(\tau^4 - a^4)s}{\tau^2\sqrt{\left(\tau^2 - s^2\right)\left(\tau^2 s^2 - a^4\right)}}$$
$$- \frac{\beta\,(\tau^4 - a^4)s}{\tau^2\sqrt{\left(\tau^2 + s^2\right)\left(\tau^2 s^2 + a^4\right)}} \qquad \text{(I24)}$$

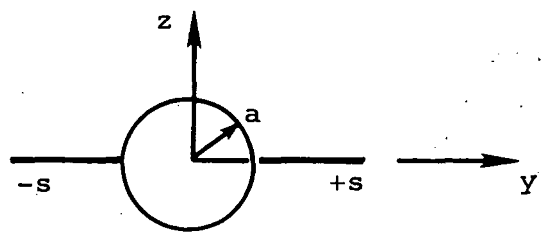
3.- Flow Field in Crossflow Plane Due to Symmetrical Deflection of Two Panels of a Planar Wing-Body Combination

3.1 Introduction

In determining the perturbation velocity components in the flow field of a cruciform wing-body combination, we must have flow field solutions (1) for no fin deflection at $\alpha \neq 0$, (2) for symmetrical fin deflection of opposing panels at $\alpha = 0$, and (3) for the deflection of a single fin of a cruciform configuration at $\alpha = 0$. The first two flow fields for a cruciform wing-body can be formed by superimposing solutions for a planar wing-body combination at right angles to each other. The first solution is given in the preceding sections; the second solution is the subject of this section, and the third solution is the subject of the next section.

3.2 Boundary Value Problem

Consider a planar wing-body combination with a circular body of radius a and a fin of total semispan s.



$\tau = y + iz$

The left and right fins are deflected trailing edge down by an angular deflection δ such that the normal velocity on the fins due to the free stream is $V_\infty \delta$. The complex velocity in the crossflow plane is $v + iw$. We have to find perturbation velocity components u,v,w at a point x,y,z in the crossflow plane. The complex variable in the crossflow plane is $\tau = y + iz$.

3.3. Method of Solution

Let $W(\tau)$ be the complex potential for crossflow about the wing-body combination in the crossflow plane at x = constant. Let the missile cross section in the τ plane be transformed to a circle of radius R_o in the σ plane. We will find a complex potential $W(\sigma)$ which when transformed back to the τ plane satisfies the boundary condition in this plane. If

$$\frac{dW}{d\sigma} = V - iW$$
$$\frac{dW}{d\tau} = v-iw = (V - iW)\left(\frac{d\sigma}{d\tau}\right) \tag{I25}$$

The transformation taking the missile cross section into the circle of radius R_o is

$$\tau + \frac{a^2}{\tau} = \sigma + \frac{R_o^2}{\sigma} \tag{I26}$$

with

$$2R_o = s + \frac{a^2}{s} \tag{I27}$$

where a is the body radius and s the fin semispan. In this transformation the field far from the cross section is undistorted. The reciprocal relationships between corresponding points in the σ and τ planes are obtained from the equations for the upper half plane

$$\sigma = \frac{1}{2}\left(\tau + \frac{a^2}{\tau}\right) + \frac{1}{2}\sqrt{\left(\tau + \frac{a^2}{\tau}\right)^2 - 4R_o^2} \tag{I28}$$

$$\tau = \frac{1}{2}\left(\sigma + \frac{R_o^2}{\sigma}\right) + \frac{1}{2}\sqrt{\left(\sigma + \frac{R_o^2}{\sigma}\right)^2 - 4a^2} \tag{I29}$$

On the circle $\sigma = R_o e^{i\theta}$, we have

$$\tau = R_o \cos\theta + R_o\sqrt{\cos^2\theta - \frac{a^2}{R_o^2}} \tag{I30}$$

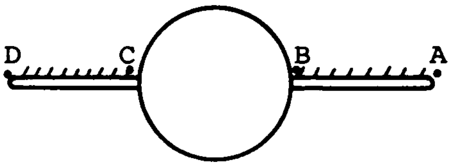
If $\theta = 0°$

$$\tau = s \tag{I31}$$

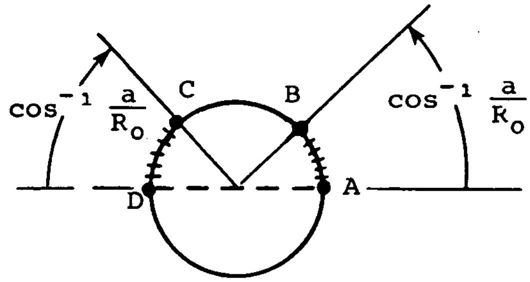
If $\cos\theta = a/R_o$, then

$$\tau = a \tag{I32}$$

These points are shown in the following sketch



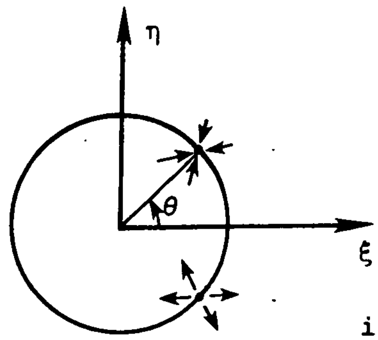
τ Plane



σ Plane

3.4 Complex Potential

To obtain the complex potential, we follow a variation of the method of Adams and Dugan (ref. 21). Consider points on the upper and lower surfaces of the right wing at the same y location between y = a and y = s.



Let the corresponding points in the σ plane be $R_o e^{i\theta_o}$ and $R_o e^{-i\theta_o}$.

Let a sink of strength dm exist at the point $R_o e^{i\theta_o}$ and a source of opposite strength exist at $R_o e^{-i\theta_o}$. The complex potential due to the sum of these two singularities is

$$dW_R = -\frac{dm}{2\pi}\,\ell n\left(\frac{\sigma - R_o e^{i\theta_o}}{\sigma - R_o e^{i\theta_o}}\right) \tag{I33}$$

The circle $R_o e^{i\theta}$ is a streamline of the flow except at the singular points. In the τ plane an amount of fluid dm/2 enters the fin from above and an amount of fluid dm/2 goes out beneath the fin. Since the upwash through the fin δV_∞ must be countered by the source-sink combination, we have

$$dm = 2\delta V_\infty dy \tag{I34}$$

Accordingly the complex potential due to the right fin is

$$W_R = -\frac{\delta V_\infty}{\pi}\int_a^s \ell n\left(\frac{\frac{\sigma}{R_o} - e^{i\theta_o}}{\frac{\sigma}{R_o} - e^{-i\theta_o}}\right) dy \tag{I35}$$

For the left fin, we have by analogy

$$dW_L = -\frac{dm}{\pi}\ \ell n\left(\frac{\sigma - R_o e^{i(\pi-\theta_o)}}{\sigma - R_o e^{i(\pi+\theta_o)}}\right)$$

$$= -\frac{dm}{2\pi}\ \ell n\left(\frac{\sigma - R_o e^{-i\theta_o}}{\sigma + R_o e^{i\theta_o}}\right)$$

$$W_L = -\frac{\delta V_\infty}{\pi}\int_{-s}^{-a} \ell n\left(\frac{\sigma + R_o e^{-i\theta_o}}{\sigma + R_o e^{i\theta_o}}\right) dy \tag{I36}$$

$$W_R + W_L = -\frac{\delta V_\infty}{\pi}\int_a^s \ell n\ \frac{\left(\sigma - R_o e^{i\theta_o}\right)\left(\sigma + R_o e^{-i\theta_o}\right)}{\left(\sigma - R_o e^{-i\theta_o}\right)\left(\sigma + R_o e^{i\theta_o}\right)}$$

$$W = -\frac{\delta V_\infty}{\pi}\int_a^s \ell n\left(\frac{\sigma^2 - R_o^2 - 2iR_o\sigma\sin\theta_o}{\sigma^2 - R_o^2 + 2iR_o\sigma\sin\theta_o}\right) dy \tag{I37}$$

To solve equation (I37) for $W(\sigma)$, we first assume that σ is real, and integrate equation (I37) on this basis. We then invoke the principle of analytic continuation, and assume the result is valid for σ complex. The complex velocity in the τ plane is determined by

$$v - iw = \frac{dW}{d\sigma}\frac{d\sigma}{d\tau} \qquad \text{(I38)}$$

and it can be examined to make sure it satisfies the boundary conditions. Setting

$$\frac{\sigma^2 - R_o^2}{2R_o\sigma} = \lambda \qquad \text{(I39)}$$

$$W = -\frac{\delta V_\infty}{\pi}\int_a^s \ell n \left(\frac{\lambda - i\sin\theta_o}{\lambda + i\sin\theta_o}\right) dy \qquad \text{(I40)}$$

Integrating by parts

$$W = -\frac{\delta V_\infty}{\pi}\left[-a\,\ell n\left(\frac{\lambda - i\sqrt{1 - \frac{a^2}{R_o^2}}}{\lambda + i\sqrt{1 - \frac{a^2}{R_o^2}}}\right) + i\int_a^s \frac{y\,d(\sin\theta_o)}{\lambda - i\sin\theta_o} + i\int_a^s \frac{y\,d(\sin\theta_o)}{\lambda + i\sin\theta_o}\right] \qquad \text{(I41)}$$

Let

$$I_1 = \int_a^s \frac{y\,d(\sin\theta_o)}{\lambda - i\sin\theta_o}$$

$$I_2 = \int_a^s \frac{y\,d(\sin\theta_o)}{\lambda + i\sin\theta_o}$$

With the help of subsequent results in section 3.6 for $I_1 + I_2$, we obtain

$$W(\sigma,a,R_o) = -\frac{\delta V_\infty}{\pi}\left\{-a\,\ell n\left(\frac{\lambda - i\sqrt{1 - \frac{a^2}{R_o^2}}}{\lambda + i\sqrt{1 + \frac{a^2}{R_o^2}}}\right)\right.$$

(equation continued on next page)

$$- 2iR_o\sqrt{\lambda^2 + 1}\,\tan^{-1}\left(\frac{\sqrt{\lambda^2+1}}{\lambda}\;\frac{\sqrt{1 - \frac{a^2}{R_o^2}}}{\frac{a}{R_o}}\right)$$

$$\left. - iR_o\pi\sqrt{\lambda^2 + 1 - \frac{a^2}{R_o^2}} + 2\lambda R_o i\left[\frac{\pi}{2} + \cos^{-1}\left(\frac{a}{R_o}\right)\right]\right\} \tag{I42}$$

3.5 Crossflow Velocity Components

Having the complex potential, we may now obtain the velocity components in the σ plane and the τ plane.

$$V - iW = \frac{dW}{d\lambda}\left(\frac{d\lambda}{d\sigma}\right) \tag{I43}$$

We will carry out the differentiation

$$\ell n\left(\frac{\lambda - i\sqrt{1 - \frac{a^2}{R_o^2}}}{\lambda + i\sqrt{1 - \frac{a^2}{R_o^2}}}\right) = \left(-2i\,\tan^{-1}\frac{\sqrt{1 - \frac{a^2}{R_o^2}}}{\lambda}\right) \tag{I44}$$

$$\frac{d}{d\lambda}\,\ell n\left(\frac{\lambda - i\sqrt{1 - \frac{a^2}{R_o^2}}}{\lambda + i\sqrt{1 - \frac{a^2}{R_o^2}}}\right) = \frac{+\,2i\sqrt{1 - \frac{a^2}{R_o^2}}}{\lambda^2 + 1 - \frac{a^2}{R_o^2}} \tag{I45}$$

$$\frac{d\lambda}{d\sigma} = \frac{\sigma^2 + R_o^2}{2R_o\sigma^2} \qquad \lambda = \frac{\sigma^2 - R_o^2}{2R_o\sigma} \tag{I46}$$

Thus

$$\frac{d}{d\sigma}\,\ell n\left(\frac{\lambda - i\sqrt{1 - \frac{a^2}{R_o^2}}}{\lambda + i\sqrt{1 - \frac{a^2}{R_o^2}}}\right) = \frac{4iR_o\left(\sigma^2 + R_o^2\right)\sqrt{1 - \frac{a^2}{R_o^2}}}{\left(\sigma^2 + R_o^2\right)^2 - 4a^2\sigma^2} \tag{I47}$$

The other differentiation yields

$$\frac{d}{d\sigma}\left[\sqrt{\lambda^2 + 1}\,\tan^{-1}\left(\frac{\sqrt{\lambda^2 + 1}}{\lambda}\,\frac{\sqrt{1 - \frac{a^2}{R_o^2}}}{\frac{a}{R_o}}\right)\right] = \frac{2(\sigma^2 + R_o^2)a\sqrt{1 - \frac{a^2}{R_o^2}}}{(\sigma^2 + R_o^2)^2 - 4a^2\sigma^2}$$

$$+ \frac{(\sigma^2 - R_o^2)}{2R_o\sigma^2}\tan^{-1}\left[\left(\frac{\sigma + R_o^2}{\sigma^2 - R_o^2}\right)\left(\frac{\sqrt{1 - \frac{a^2}{R_o^2}}}{\frac{a}{R_o}}\right)\right] \tag{I48}$$

$$\frac{d}{d\sigma}\sqrt{\lambda^2 + 1 - \frac{a^2}{R_o^2}} = \frac{\sigma^4 - R_o^4}{2R_o\sigma^2}\,\frac{1}{\sqrt{(\sigma^2 + R_o^2)^2 - 4a^2\sigma^2}}$$

The expression in complex form for $V - iW$ is

$$V - iW = -\frac{\delta V_\infty}{\pi}\left\{-\frac{4iaR_o(\sigma^2 + R_o^2)\sqrt{1 - \frac{a^2}{R_o^2}}}{(\sigma^2 + R_o^2)^2 - 4a^2\sigma^2} - \frac{4iaR_o(\sigma^2 + R_o^2)\sqrt{1 - \frac{a^2}{R_o^2}}}{(\sigma^2 + R_o^2)^2 - 4a^2\sigma^2}\right.$$

$$- \frac{i(\sigma^2 - R_o^2)}{\sigma^2}\tan^{-1}\left[\left(\frac{\sigma^2 + R_o^2}{\sigma^2 - R_o^2}\right)\left(\frac{\sqrt{1 - \frac{a^2}{R_o^2}}}{\frac{a}{R_o}}\right)\right]$$

(equation continued on next page)

$$- \frac{i\pi}{2\sigma^2} \frac{(\sigma^4 - R_o^4)}{\sqrt{(\sigma^2 + R_o^2)^2 - 4a^2\sigma^2}} + \frac{i(\sigma^2 + R_o^2)}{\sigma^2}\left[\frac{\pi}{2} + \cos^{-1}\left(\frac{a}{R_o}\right)\right]\Bigg\} \qquad \text{(I49)}$$

We now determine v - iw in the τ plane

$$v - iw = (V - iW)\frac{d\sigma}{d\tau} \qquad \text{(I50)}$$

From the transformation we find the following relationships

$$\left.\begin{aligned} \frac{d\sigma}{d\tau} &= \frac{\sigma^2}{(\sigma^2 - R_o^2)} \frac{(\tau^2 - a^2)}{\tau^2} \\ \frac{\sigma^2 + R_o^2}{\sigma} &= \tau + \frac{a^2}{\tau} \\ \frac{\sigma^2 - R_o^2}{\sigma} &= \sqrt{\left(\tau + \frac{a^2}{\tau}\right)^2 - 4R_o^2} \end{aligned}\right\} \qquad \text{(I51)}$$

The following results are needed to accomplish the transformation of the results to the τ plane

$$\frac{\sigma^2 + R_o^2}{(\sigma^2 + R_o^2)^2 - 4a^2\sigma^2}\left(\frac{d\sigma}{d\tau}\right) = \frac{\frac{\sigma^2 + R_o^2}{\sigma}}{\left(\frac{\sigma^2 + R_o^2}{\sigma}\right)^2 - 4a^2} \frac{\sigma}{(\sigma^2 - R_o^2)}\left(\frac{\tau^2 - a^2}{\tau^2}\right)$$

$$= \frac{\left(\tau + \frac{a^2}{\tau}\right)}{\left[\left(\tau + \frac{a^2}{\tau}\right)^2 - 4a^2\right]} \frac{1}{\sqrt{\left(\tau + \frac{a^2}{\tau}\right)^2 - 4R_o^2}}\left(\frac{\tau^2 - a^2}{\tau^2}\right)$$

$$= \frac{(\tau^2 + a^2)}{(\tau^2 - a^2)\sqrt{(\tau^2 + a^2)^2 - 4R_o^2\tau^2}} \qquad \text{(I52)}$$

Since

$$\frac{\sigma^2 - R_o^2}{\sigma^2}\frac{d\sigma}{d\tau} = \left(\frac{\tau^2 - a^2}{\tau^2}\right) \tag{I53}$$

we find

$$\left(\frac{d\sigma}{d\tau}\right)\left(\frac{\sigma^2 - R_o^2}{\sigma^2}\right)\tan^{-1}\left[\left(\frac{\sigma^2 + R_o^2}{\sigma^2 - R_o^2}\right)\frac{\sqrt{1 - \frac{a^2}{R_o^2}}}{\frac{a}{R_o}}\right] = \left(\frac{\tau^2 - a^2}{\tau^2}\right)\tan^{-1}\left[\frac{(\tau^2 + a^2)\sqrt{1 - \frac{a^2}{R_o^2}}}{\left(\frac{a}{R_o}\right)\sqrt{(\tau^2 + a^2)^2 - 4R_o^2\tau^2}}\right] \tag{I54}$$

$$\frac{\sigma^4 - R_o^4}{\sigma^2\sqrt{(\sigma^2 + R_o^2)^2 - 4a^2\sigma^2}}\left(\frac{d\sigma}{d\tau}\right) = \frac{(\tau^2 + a^2)}{\tau^2} \tag{I55}$$

$$\frac{\sigma^2 + R_o^2}{\sigma^2}\frac{d\sigma}{d\tau} = \frac{\tau^4 - a^4}{\tau^2\sqrt{(\tau^2 + a^2)^2 - 4R_o^2\tau^2}} \tag{I56}$$

These results yield the complex velocity in the τ plane.

$$(v - iw) = \frac{\delta V_\infty}{\pi}\left\{i\left(\frac{\tau^2 - a^2}{\tau^2}\right)\tan^{-1}\left[\frac{(\tau^2 + a^2)\sqrt{1 - \frac{a^2}{R_o^2}}}{\left(\frac{a}{R_o}\right)\sqrt{(\tau^2 + a^2)^2 - 4R_o^2\tau^2}}\right]\right.$$

(equation continued on next page)

$$+ i\left(\frac{\pi}{2}\right) \frac{\tau^2 + a^2}{\tau^2} - \frac{i}{\sqrt{(\tau^2 + a^2)^2 - 4R_o^2\tau^2}} \left(\frac{\tau^4 - a^4}{\tau^2}\right) \left[\frac{\pi}{2} + \cos^{-1}\left(\frac{a}{R_o}\right)\right] \Bigg\} \tag{I57}$$

The expression can be broken down into real and imaginary parts to obtain v and w, but is probably more convenient to obtain v - iw on the computer using complex calculations.

3.6 Evaluation of Certain Definite Integrals

The following integrals are to be evaluated

$$I_1 = \int_{\sqrt{1-a^2/R_o^2}}^{o} \frac{y\, d(\sin\theta)}{\lambda - i\sin\theta} \tag{I58}$$

$$I_2 = \int_{\sqrt{1-a^2/R_o^2}}^{o} \frac{y\, d(\sin\theta)}{\lambda + i\sin\theta} \tag{I59}$$

where

$$y = R_o\left[\cos\theta + \sqrt{1 - \frac{a^2}{R_o^2} - \sin^2\theta}\right] \tag{I60}$$

We want the sum $I_1 + I_2$ in particular

$$I_1 + I_2 = 2\lambda R_o \int_{\sqrt{1-a^2/R_o^2}}^{o} \frac{1}{\lambda^2 + \sin^2\theta}\left(\cos\theta + \sqrt{1 - \frac{a^2}{R_o^2} - \sin^2\theta}\right) d(\sin\theta) \tag{I61}$$

$$= 2\lambda R_o \left[(1+\lambda^2)\int_{\cos^{-1}a/R_o}^{o} \frac{d\theta}{(\lambda^2 + \sin^2\theta)} - \int_{\cos^{-1}a/R_o}^{o} d\theta\right.$$

(equation continued on next page)

$$+\left(1-\frac{a^2}{R_o^2}+\lambda^2\right)\int_{\sqrt{1-a^2/R_o^2}}^{o}\frac{d(\sin\theta)}{(\lambda^2+\sin^2\theta)\sqrt{1-\frac{a^2}{R_o^2}-\sin^2\theta}}$$

$$\left.-\int_{\sqrt{1-a^2/R_o^2}}^{o}\frac{d(\sin\theta)}{\sqrt{1-\frac{a^2}{R_o^2}-\sin^2\theta}}\right] \tag{I62}$$

(Concluded)

We now integrate each of the four separate integrals. From pg. 323 in reference 19.

$$\int_{\cos^{-1}(a/R_o)}^{o}\frac{d\theta}{(\lambda^2+\sin^2\theta)}=\frac{1}{\sqrt{\lambda^2(\lambda^2+1)}}\tan^{-1}\left[\frac{\sqrt{\lambda^2(\lambda^2+1)}\tan\theta}{\lambda^2}\right]\Bigg|_{\cos^{-1}(a/R_o)}^{o}$$

$$=-\frac{1}{\lambda\sqrt{\lambda^2+1}}\tan^{-1}\left[\frac{\sqrt{\lambda^2+1}}{\lambda}\frac{\sqrt{1-\frac{a^2}{R_o^2}}}{\left(\frac{a}{R_o}\right)}\right] \tag{I63}$$

$$\int_{\cos^{1}(a/R_o)}^{o}d\theta=-\cos^{-1}\left(\frac{a}{R_o}\right) \tag{I64}$$

The third integral can be evaluated with the help of the following result from page 55 in reference 20.

$$\int\frac{dx}{(\lambda^2+x^2)\sqrt{\nu^2-x^2}}=\frac{1}{\lambda\sqrt{\lambda^2+\nu^2}}\tan^{-1}\frac{x\sqrt{\lambda^2+\nu^2}}{\lambda\sqrt{\nu^2-x^2}}+C \tag{I65}$$

$$\int_{\sqrt{1-a^2/R_o^2}}^{o}\frac{d(\sin\theta)}{(\lambda^2+\sin^2\theta)\sqrt{1-\frac{a^2}{R_o^2}-\sin^2\theta}}=\frac{1}{\lambda\sqrt{\lambda^2+1-\frac{a^2}{R_o^2}}}$$

$$\tan^{-1}\left[\frac{\sqrt{\lambda^2 + 1 - \frac{a^2}{R_o^2}}\sin\theta}{\lambda\sqrt{1 - \frac{a^2}{R_o^2} - \sin^2\theta}}\right]\Bigg|_{\sqrt{1-a^2/R_o^2}}^{o} = -\left(\frac{\pi}{2}\right)\frac{1}{\lambda\sqrt{\lambda^2 + 1 - \frac{a^2}{R_o^2}}} \tag{I66}$$

The fourth integral is

$$\int_{\sqrt{1-a^2/R_o^2}}^{o} \frac{d(\sin\theta)}{\sqrt{1 - \frac{a^2}{R_o^2} - \sin^2\theta}} = \sin^{-1}\left(\frac{\sin\theta}{\sqrt{1 - \frac{a^2}{R_o^2}}}\right)\Bigg|_{\sqrt{1-a^2/R_o^2}}^{o}$$

$$= -\frac{\pi}{2} \tag{I67}$$

Finally we have

$$I_1 + I_2 = 2\lambda R_o\left\{-\frac{\sqrt{\lambda^2 + 1}}{\lambda}\tan^{-1}\left(\frac{\sqrt{\lambda^2 + 1}}{\lambda}\,\frac{\sqrt{1 - \frac{a^2}{R_o^2}}}{\frac{a}{R_o}}\right)\right.$$

$$\left. + \cos^{-1}\left(\frac{a}{R_o}\right) - \frac{\pi}{2}\left(\frac{\sqrt{\lambda^2 + 1 - \frac{a^2}{R_o^2}}}{\lambda}\right) + \frac{\pi}{2}\right\} \tag{I68}$$

4.- Flow Field in Crossflow Plane Due to Deflection of a Single Panel on a Cruciform Wing-Body Combination

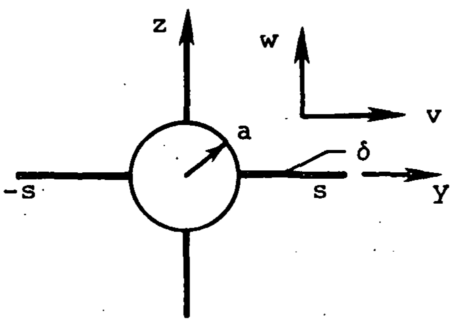
4.1 Introduction

For a cruciform wing-body with no panel deflection, the flow field based on slender-body theory is given in section 2. However, the general flow field due to panel deflection is not known. From the results for single panel deflection, the effect of arbitrary deflections of all four panels can be obtained by superposition. This result will now be derived.

4.2 Boundary Value Problem

Consider the cross section of a cruciform wing-body combination at zero roll angle and zero angle of attack but with the right fin deflected by angle, δ, positive trailing edge down. The crossflow plane is designated by the complex variable

$$\tau = y + iz$$



The body radius is "a" and the fin semispan is "s". The vector velocity in the crossflow plane is v + iw, and the axial component of velocity is "u". Let the right panel be deflected by the angle δ so that free-stream velocity V_∞ causes an uniform upwash $V_\infty \sin\delta$ through the fin. We must find a potential ϕ which produces equal and opposite downwash on the right fin and at the same time causes no flow normal to the other fins or the body. We then are to find the flow velocity components u and w at points x,y,z in the field due to this potential. The quantities a and s can be functions of x.

4.3 Method of Solution

The method of solution is to find the complex potential W which produces unit velocity at a given point on the deflected wing in the range $a \leq y \leq s$ and zero at all other points. Then the effect of all such fundamental solutions over the range is summed by integration. The fundamental solution is that given by Adams and Dugan in reference 21. The velocity components are found by differentiation of W.

In obtaining the solution, recourse will be had to the theory of conformal transformation. In this connection let the cross-section of the cruciform wing-body combination in the τ plane be transformed into a circle of radius R in the σ plane with

$$\sigma = \xi + i\eta \tag{I69}$$

Such a transformation is given as

$$\tau^2 + \frac{a^4}{\tau^2} = \sigma^2 + \frac{R^4}{\sigma^2} \tag{I70}$$

with

$$2R^2 = s^2 + \frac{a^4}{s^2} \tag{I71}$$

The reciprocal relationships between points in the τ and σ planes are

$$\left.\begin{aligned} \sigma &= \frac{1}{2}\sqrt{\left(\tau^2 + \frac{a^4}{\tau^2}\right) - 2R^2} + \sqrt{\left(\tau^2 + \frac{a^4}{\tau^2}\right) + 2R^2} \\ \tau &= \frac{1}{2}\sqrt{\left(\sigma^2 + \frac{R^4}{\sigma^2}\right) - 2a^2} + \sqrt{\left(\sigma^2 + \frac{R^4}{\sigma^2}\right) + 2a^2} \end{aligned}\right\} \tag{I72}$$

In these relationships we confine our attention to the upper half plane. In equation (I70) we have put the fields at ∞ into the identity relationship

$$\sigma \to \tau \quad \text{as} \quad \tau \to \infty \tag{I73}$$

A point $Re^{i\theta_o}$ on the circle $Re^{i\theta}$ corresponds to y_o in the physical plane. From equation (I70)

$$2R^2 \left(\frac{e^{2i\theta_o} + e^{-2i\theta_o}}{2}\right) = y_o^2 + \frac{a^4}{y_o^2} \tag{I74}$$

so that

$$\frac{y_o^2}{R^2} = \cos 2\theta_o + \sqrt{\left(\cos 2\theta_o - \frac{a^2}{R^2}\right)\left(\cos 2\theta_o + \frac{a^2}{R^2}\right)} \tag{I75}$$

and

$$\frac{y_o}{R} = \frac{1}{\sqrt{2}}\left[\sqrt{\cos 2\theta_o - \frac{a^2}{R}} + \sqrt{\cos 2\theta_o + \frac{a^2}{R}}\right] \tag{I76}$$

If $y_o = s$, then from equation (I74) and (I71)

$$2R^2 \cos 2\theta_o = 2R^2$$

or

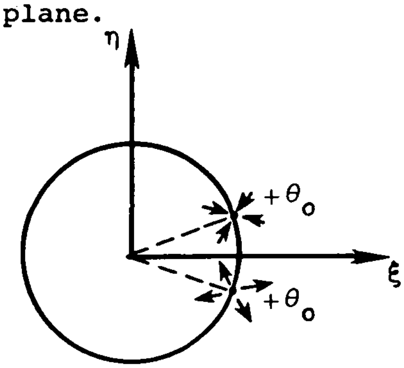
$$\theta_o = 0; \quad y = s \tag{I77}$$

Let the point $Re^{i\gamma}$ correspond in the σ plane to $y = a$ in the τ plane. Then from equation (I74)

$$\cos 2\gamma = \frac{a^2}{R^2} \tag{I78}$$

4.4 Complex Potential

To obtain the complex potential for the fundamental solution, we follow the method of Adams and Dugan. Consider points on the upper and lower surfaces of the wing at $y = y_o$ and consider a sink of strength dm at $Re^{i\theta_o}$ and a source at point $Re^{-i\theta_o}$ in the σ plane, corresponding to the two points at $y=y_o$ in the τ plane.



The complex potential for the sink is (assuming dm is positive)

$$dW_1 = -\frac{dm}{2\pi}\ln(\sigma - Re^{i\theta_o})$$

and for the pair, we have

$$dW = \frac{-dm}{2\pi}\ln\left(\frac{\sigma - Re^{i\theta_o}}{\sigma - Re^{-i\theta_o}}\right) \tag{I79}$$

It can be shown that the circle

$$\sigma = Re^{i\theta}$$

is a streamline of the complex potential given by equation (I79) although the points $Re^{i\theta_o}$ and $Re^{-i\theta_o}$ are singular points since many streamline converge at these points, with a net mass flow through the circle at these points. Since ϕ and ψ are equal at corresponding points in the τ and σ planes in the conformal transformation of the flow, we can evaluate ψ on the wing panel in the τ plane. Let the velocity components in the

τ plane be v and w. Then on the wing panel

$$\frac{d\psi_o}{dy_o} = -w = +\ \delta V_\infty; \qquad a \leq y_o \leq s \tag{I80}$$

Now since only half the source or sink flow passes through the fin

$$\frac{dm}{2} = \delta V_\infty dy \tag{I81}$$

and we have

$$dm = 2d\psi_o = 2\delta V_\infty dy_o \tag{I82}$$

Now summing all sources and sinks along both sides of the right panel between $a \leq y_o \leq s$, we have

$$W = -\frac{1}{\pi}\int_{\psi(a)}^{\psi(s)} \ell n \left(\frac{\sigma - Re^{i\theta_o}}{\sigma - Re^{-i\theta_o}}\right) d\psi_o \tag{I83}$$

Integrating by parts, yields

$$W(\sigma) = \frac{\psi(\gamma)}{\pi}\ \ell n \left(\frac{\sigma - Re^{i\gamma}}{\sigma - Re^{-i\gamma}}\right) - \frac{1}{\pi}\int_o^\gamma \psi(\theta_o)\ \frac{d}{d\theta_o}\left[\ell n \left(\frac{\sigma - Re^{+i\theta_o}}{\sigma - Re^{-i\theta_o}}\right)\right] d\theta_o$$

$$W(\sigma) = \frac{\psi(\gamma)}{\pi}\ \ell n \left(\frac{\sigma - Re^{+i\gamma}}{\sigma - Re^{-i\gamma}}\right) - \frac{2iR}{\pi}\int_o^\gamma \frac{(\sigma\cos\theta_o - R)\psi(\theta_o)d\theta_o}{\sigma^2 - 2\sigma R\cos\theta_o + R^2} \tag{I84}$$

We now evaluate ψ_o by integrating equation (I80)

$$\psi_o = \delta V_\infty y_o + k \tag{I85}$$

where k is an arbitrary constant which we will set equal to zero. We thus find the complex potential

$$W(\sigma) = \frac{\delta V_\infty}{\pi}\left\{a\ \ell n \left(\frac{\sigma - Re^{i\gamma}}{\sigma - Re^{i\gamma}}\right) - i\sqrt{2}\,R^2\int_o^\gamma \frac{(\sigma\cos\theta_o - R)\left[\sqrt{\cos 2\theta_o - \frac{a^2}{R^2}} + \sqrt{\cos 2\theta_o + \frac{a^2}{R^2}}\right]}{(\sigma^2 - 2\sigma R\cos\theta_o + R^2)} d\theta_o\right\} \tag{I86}$$

APPENDIX I

The expression of equation (I86) is the one which will be used to determine u, v and w. Several approaches are possible. First we might consider σ as a real quantity, and integrate equation (I86) to obtain $W(\sigma)$. Then invoking the principle of analytical continuation, we would assume σ was complex again, and separate $W(\sigma)$ into ϕ and ψ. Differentiation of ϕ then leads to u, v, and w. This approach was tried and the part of the second integral involving $\sqrt{\cos 2\theta_o - a^2/R^2}$ yields complete elliptical integrals of the third kind. The second part involving $\sqrt{\cos 2\theta_o + a^2/R^2}$ yields incomplete elliptic integrals of the third kind. To separate such an incomplete elliptic integral into real and imaginary parts was considered too formidable a task so that an alternate approach was decided. In this approach $W(\sigma)$ is differentiated, and an expression for $V - iW$ is obtained. Complex integration then yields V and W, the velocity components in the σ plane.

4.5 Determination of V and W

We will determine V, and W by carrying out the operation

$$V - iW = \frac{dW}{d\sigma} \tag{I87}$$

on equation (I86) and evaluating the complex integral. Carrying out the operations yields

$$\frac{V - iW}{\delta V_\infty/\pi} = \frac{a}{\sigma - Re^{i\gamma}} - \frac{a}{\sigma - Re^{-i\gamma}}$$

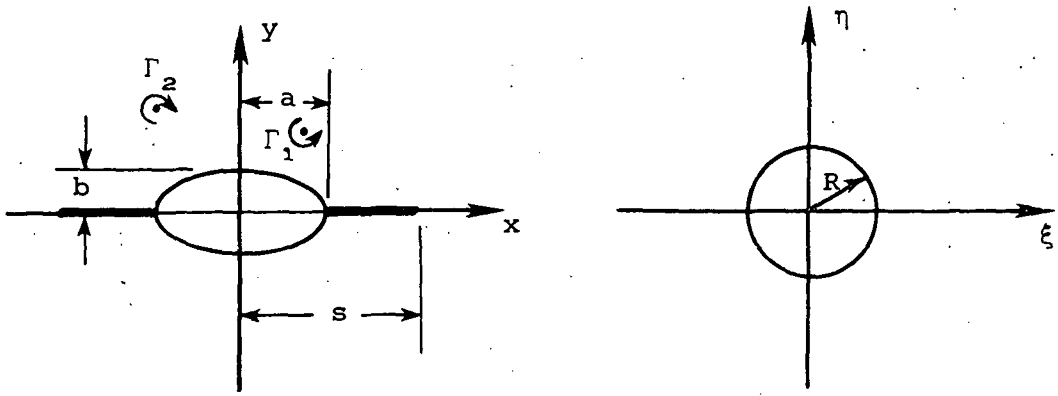
$$+ i\sqrt{2}\, R^2 \int_0^{\gamma} \frac{\left[(\sigma^2+R^2)\cos\theta_o - 2R\sigma\right]\left[\sqrt{\cos 2\theta_o + a^2/R^2} + \sqrt{\cos 2\theta_o - a^2/R^2}\right] d\theta_o}{(\sigma^2 - 2\sigma R\cos\theta_o + R^2)^2} \tag{I88}$$

Equation (I88) is solved numerically.

5.- Velocities on a Vortex Due to Other Vortices in the Crossflow Plane in the Presence of a Monoplane Midwing Mounted on a Body of Elliptic Cross-Section

5.1 Conformal Mapping

As the first step in the analysis, we transform the elliptical configuration into a circle of radius R.

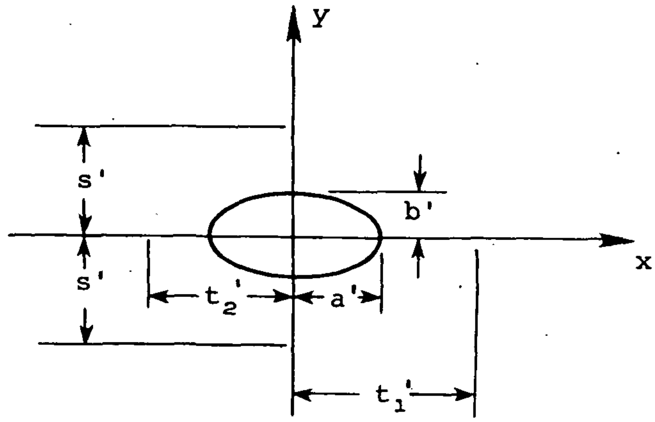


real plane: $Z = x + iy$ transformed plane: $\zeta = \xi + i\eta$

Bryson (ref. 22) has presented the desired conformal mapping for an elliptical body with wings and vertical tail. Bryson's configuration is rotated 90° from the present one. The conformal mapping for the configuration shown below is:

$$Z = w + \frac{a'^2 - b'^2}{4w} \tag{I89}$$

$$\left[w + \frac{(a' + b')^2}{4w}\right]^2 = \left[\frac{h-f}{2} + \zeta + \frac{(h+f)^2}{16\zeta}\right]^2 - k^2 \tag{I90}$$



where

$$k = \sigma - \left[\frac{(a' + b')^2}{4\sigma}\right] \tag{I91}$$

$$h^2 = k^2 + \left[\tau_1 + \frac{(a' + b')^2}{4\tau_1}\right]^2 \tag{I92}$$

$$f^2 = k^2 + \left[\tau_2 + \frac{(a' + b')^2}{4\tau_2}\right]^2 \tag{I93}$$

and

$$\sigma = \frac{1}{2}\left(s' + \sqrt{s'^2 + a'^2 - b'^2}\right) \tag{I94}$$

$$\tau_1 = \frac{1}{2}\left(t_1' + \sqrt{t_1'^2 - a'^2 + b'^2}\right) \tag{I95}$$

$$\tau_2 = \frac{1}{2}\left(t_2' + \sqrt{t_2'^2 - a'^2 + b'^2}\right) \tag{I96}$$

For a configuration consisting of a monoplane midwing attached to the body with elliptical cross section (i.e. no vertical surfaces), we get the following special results.

$$t_1' = t_2' = s \tag{I97}$$

$$a' = a \tag{I98}$$

$$b' = b \tag{I99}$$

$$s' = b' = b \tag{I100}$$

In addition, we obtain

$$\tau_1 = \tau_2 = \frac{1}{2}\left(s + \sqrt{s^2 - a^2 + b^2}\right) \tag{I101}$$
$$= \tau$$

$$\sigma = \frac{1}{2}(b + a) \tag{I102}$$

$$k = \frac{1}{2}(a + b) - \frac{(a + b)^2}{2(a + b)} = 0 \tag{I103}$$

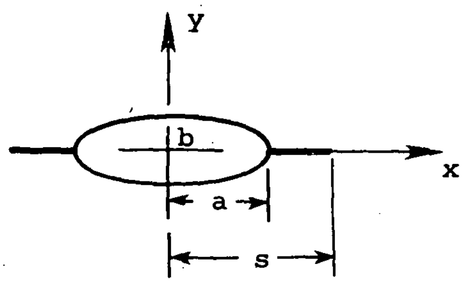
$$h = f = \tau + \frac{\sigma^2}{\tau} \tag{I104}$$

The required conformal mapping without the tail fins is

$$Z = w + \frac{a^2 - b^2}{4w} \tag{I105}$$

with

$$w + \frac{\sigma^2}{w} = \zeta + \frac{(h/2)^2}{\zeta} \tag{I106}$$



where

$$\sigma = \frac{1}{2}(a + b) \tag{I107}$$

$$h = \tau + \frac{\sigma^2}{\tau} \tag{I108}$$

$$\tau = \frac{1}{2}\left(s + \sqrt{s^2 - a^2 + b^2}\right) \tag{I109}$$

The radius of the circle in the transformed plane is

$$R = \frac{h}{2} = \frac{1}{4}\left[s + \sqrt{s^2 - a^2 + b^2} + \frac{(a + b)^2}{s + \sqrt{s^2 - a^2 + b^2}}\right] \tag{I110}$$

From equation (I106)

$$w = \frac{1}{2}\left\{\zeta + \frac{(h/2)^2}{\zeta} \pm \sqrt{\left[\zeta + \frac{(h/2)^2}{\zeta}\right]^2 - (a + b)^2}\right\} \tag{I111}$$

also, from equation (I105)

$$w = \frac{1}{2}\left(z + \sqrt{z^2 - a^2 + b^2}\right) \qquad \text{(I112)}^*$$

and, from equation (I106)

$$\zeta = \frac{1}{2}\left[w + \frac{\sigma^2}{w} \pm \sqrt{\left(w + \frac{\sigma^2}{w}\right)^2 - h^2}\right] \qquad \text{(I113)}^*$$

The choice of signs in equations (I111) and (I113) will now be addressed. When evaluating these equations, use of the positive (+) sign will produce the correct result if the square root function is evaluated properly. The rule to follow in evaluating the square roots, is that the result should be a complex quantity in the same quadrant as the complex quantity appearing in the argument. This is particularly important if the original quantity is a negative real number. Thus, if:

$$\zeta + \frac{(h/2)^2}{\zeta} = -A$$

Then,

$$\left[\zeta + \frac{(h/2)^2}{\zeta}\right]^2 - (a + b)^2 = A^2 - (a + b)^2$$

Assuming $A^2 >> (a + b)^2$, the square root of this is positive, and $\approx \pm A$. Then, for equation (I111)

$$w \approx \frac{1}{2}\,[-A \pm A] = 0$$

This does not follow from equation (I106) which suggests that if $\zeta + \frac{(h/2)^2}{\zeta}$ is large, then w should also be large. Thus, the proper solution of the square root would use the negative sign. In complex notation:

$$\zeta + \frac{(h/2)^2}{\zeta} = Ae^{i\pi}$$

Therefore,

---

*For body with elliptical cross section it can be shown that $w = \zeta$. Set $s = a$ in equation (I110), then compare equations (I111) and (I113).

$$\left[\zeta + \frac{(h/2)^2}{\zeta}\right]^2 - (a+b)^2 = A^2 e^{i2\pi} - (a+b)^2$$

$$= \left[A^2 - (a+b)^2\right] e^{i2\pi}$$

so that

$$\left[\zeta + \frac{(h/2)^2}{\zeta}\right]^2 - (a+b)^2 = \sqrt{A^2 - (a+b)^2}\ e^{i\pi}$$

$$= -\sqrt{A^2 - (a+b)^2}$$

5.2 Velocity of Vortex in Plane of Elliptical Wing-Body

In the circle plane, the complex potential for a set of vortices in the presence of the circle of radius R is given by equation (I5) as follows

$$W_1(\zeta) = -\frac{i}{2\pi}\Gamma_0\, \ell n\,(\zeta - \zeta_0) + \frac{i}{2\pi}\Gamma_0\, \ell n\left(\zeta - \frac{R^2}{\bar{\zeta}_0}\right) - \frac{i}{2\pi}\sum_{j=1}^{N}\Gamma_j\, \ell n\left(\frac{\zeta - \zeta_j}{\zeta - \frac{R^2}{\bar{\zeta}_j}}\right) \qquad \text{(I114)}$$

To find the motion of vortex Γ_0 in the Z plane the proper complex potential must take account of the fact that Γ_0 induces no velocity on itself

$$W_{\Gamma_0}(Z) = W_1\left(\zeta(Z)\right) + \frac{i\Gamma_0}{2\pi}\,\ell n\,(Z - Z_0) \qquad \text{(I115)}$$

The velocity of the vortex at Z_0 is then:

$$v_0 - iw_0 = \lim_{Z\to Z_0}\left\{\frac{d}{dZ}\left[W_{\Gamma_0}(Z)\right]\right\} \qquad \text{(I116)}$$

Equation (I116) yields

$$\frac{d}{dZ}\left[W_{\Gamma_0}(Z)\right] = \frac{d}{dZ}\left[-\frac{i}{2\pi}\Gamma_0\, \ell n\left(\frac{\zeta - \zeta_0}{Z - Z_0}\right)\right] + \frac{d}{dZ}\left[\frac{i\Gamma_0}{2\pi}\,\ell n\left(\zeta - \frac{R^2}{\overline{\zeta}_0}\right)\right]$$

$$- \frac{i}{2\pi}\frac{d}{dZ}\sum_{j=1}^{N}\Gamma_j\, \ell n\left(\frac{\zeta - \zeta_j}{\zeta - \dfrac{R^2}{\overline{\zeta}_j}}\right) \tag{I117}$$

The first term presents a problem which must be resolved by the following limiting process

$$-\frac{i\Gamma_0}{2\pi}\frac{d}{dZ}\left[\ell n\left(\frac{\zeta - \zeta_0}{Z - Z_0}\right)\right] = -\frac{i\Gamma_0}{2\pi}\left[\frac{Z - Z_0}{\zeta - \zeta_0}\right]\left[\frac{1}{Z - Z_0}\frac{d\zeta}{dZ} - \frac{\zeta - \zeta_0}{(Z - Z_0)^2}\right]$$

$$= \frac{i\Gamma_0}{2\pi}\left[\frac{1}{Z - Z_0} - \frac{1}{\zeta - \zeta_0}\frac{d\zeta}{dZ}\right] \tag{I118}$$

Expand ζ in a Taylor series about Z_0.

$$\zeta = \zeta(Z)$$

$$\zeta - \zeta_0 = (Z - Z_0)\left.\frac{d\zeta}{dZ}\right|_{Z_0} + \frac{1}{2}(Z - Z_0)^2\left.\frac{d^2\zeta}{dZ^2}\right|_{Z_0}$$

$$+ \frac{1}{6}(Z - Z_0)^3\left.\frac{d^3\zeta}{dZ^3}\right|_{Z_0} + 0(Z - Z_0)^4$$

$$\frac{d\zeta}{dZ} - \left.\frac{d\zeta}{dZ}\right|_{Z_0} = (Z - Z_0)\left.\frac{d^2\zeta}{dZ^2}\right|_{Z_0} + \ldots \tag{I119}$$

Then

$$\frac{\zeta - \zeta_0}{Z - Z_0} = \left.\frac{d\zeta}{dZ}\right|_{Z_0} + \frac{1}{2}(Z - Z_0)\left.\frac{d^2\zeta}{dZ^2}\right|_{Z_0} + \frac{1}{6}(Z - Z_0)^2\left.\frac{d^3\zeta}{dZ^3}\right|_{Z_0}$$

$$+ 0(Z - Z_0)^3 \tag{I120}$$

Applying the limiting process to equation (I118), the result is

$$\lim_{Z\to Z_0}\left\{-\frac{i\Gamma_0}{2\pi}\frac{d}{dZ}\left[\ell n\,\frac{\zeta-\zeta_0}{Z-Z_0}\right]\right\}=\frac{i\Gamma_0}{2\pi}\lim_{Z\to Z_0}\frac{1}{(\zeta-\zeta_0)}\left[\frac{(\zeta-\zeta_0)}{Z-Z_0}-\frac{d\zeta}{dZ}\right]$$

$$=\frac{i\Gamma_0}{2\pi}\lim_{Z\to Z_0}\frac{1}{\zeta-\zeta_0}\left[\frac{1}{2}(Z-Z_0)\left.\frac{d^2\zeta}{dZ^2}\right|_{Z_0}+\frac{1}{6}(Z-Z_0)^2\left.\frac{d^3\zeta}{dZ^3}\right|_{Z_0}+\ldots\right.$$
$$\left.-(Z-Z_0)\left.\frac{d^2\zeta}{dZ^2}\right|_{Z_0}-\ldots\right] \qquad \text{(I121)}$$

by substitution from equation (I119) and (I120). Since

$$\lim_{Z\to Z_0}\frac{Z-Z_0}{\zeta-\zeta_0}=\left.\frac{dZ}{d\zeta}\right|_{Z_0} \qquad \text{(I122)}$$

we finally obtain for the first term

$$\lim_{Z\to Z_0}\left\{-\frac{i\Gamma_0}{2\pi}\frac{d}{dZ}\left[\ell n\left(\frac{\zeta-\zeta_0}{Z-Z_0}\right)\right]\right\}=-\frac{i\Gamma_0}{2\pi}\left.\frac{dZ}{d\zeta}\right|_{Z_0}\left.\frac{d^2\zeta}{dZ^2}\right|_{Z_0} \qquad \text{(I123)}$$

Carrying out the remaining differentiation yields an expression for the velocity at vortex Γ_0 due to the other vortices

$$v_0-iw_0=-\frac{i\Gamma_0}{4\pi}\left.\frac{dZ}{d\zeta}\right|_{Z_0}\left.\frac{d^2\zeta}{dZ^2}\right|_{Z_0}+\frac{i\Gamma_0}{2\pi}\frac{\bar{\zeta}_0}{\zeta_0\bar{\zeta}_0-R^2}\left.\frac{d\zeta}{dZ}\right|_{Z_0}$$
$$-\frac{i}{2\pi}\sum_{j=1}^{N}\Gamma_j\left[\frac{1}{\zeta_0-\zeta_j}-\frac{\bar{\zeta}_j}{\zeta_0\bar{\zeta}_j-R^2}\right]\left.\frac{d\zeta}{dZ}\right|_{Z_0} \qquad \text{(I124)}$$

5.3 Evaluation of Certain Derivatives

We now evaluate the derivatives $\frac{dZ}{d\zeta}$ and $\frac{d^2\zeta}{dZ^2}$ required in equation (I124). From equations (I105) and (I111)

$$\frac{dZ}{d\zeta} = \frac{dZ}{dw}\frac{dw}{d\zeta} = \frac{1}{2}\left[1 - \frac{a^2 - b^2}{4w^2}\right]\left[1 - \frac{R^2}{\zeta^2}\right]\left[1 + \frac{\zeta + \frac{R^2}{\zeta}}{\sqrt{\left(\zeta + \frac{R^2}{\zeta}\right)^2 - (a+b)^2}}\right] \tag{I125}$$

From equations (I112) and (I113)

$$\frac{d\zeta}{dZ} = \frac{d\zeta}{dw}\frac{dw}{dZ} = \frac{1}{2}\left[1 - \frac{\sigma^2}{w^2}\right]\left[1 + \frac{w + \frac{\sigma^2}{w}}{\sqrt{\left(w + \frac{\sigma^2}{w}\right)^2 - h^2}}\right]\frac{dw}{dZ} \tag{I126}$$

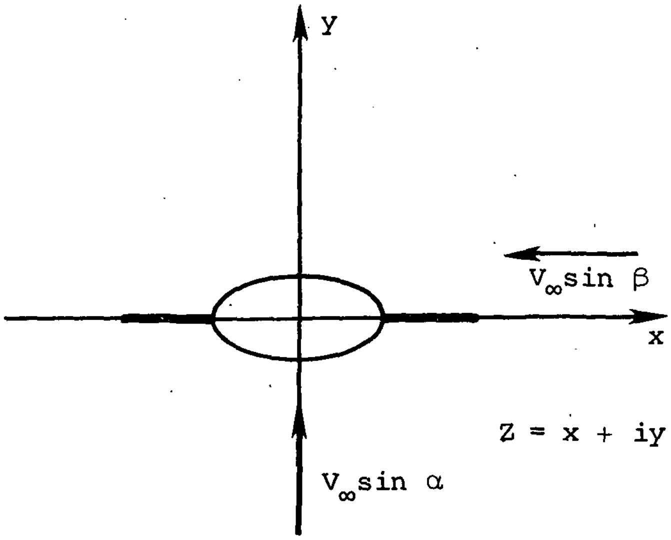
$$\frac{dw}{dZ} = \frac{1}{2}\left(1 + \frac{Z}{\sqrt{Z^2 - a^2 + b^2}}\right) \tag{I127}$$

For the second derivative, we thus find

$$\begin{aligned}
\frac{d^2\zeta}{dZ^2} &= \frac{d}{dZ}\left[\frac{d\zeta}{dZ}\right] = \frac{dw}{dZ}\frac{d}{dw}\left[\frac{d\zeta}{dZ}\right] \\
&= \left(\frac{dw}{dZ}\right)^2 \frac{d}{dw}\left[\frac{1}{2}\left(1 - \frac{\sigma^2}{w^2}\right)\left(1 + \frac{w + \frac{\sigma^2}{w}}{\sqrt{\left(w + \frac{\sigma^2}{w}\right)^2 - h^2}}\right)\right] \\
&= \left(\frac{dw}{dZ}\right)^2 \left[\frac{\sigma^2}{w^3}\left(1 + \frac{w + \frac{\sigma^2}{w}}{\sqrt{\left(w + \frac{\sigma^2}{w}\right)^2 - h^2}}\right)\right. \\
&\quad \left. - \frac{1}{2}\left(1 - \frac{\sigma^2}{w^2}\right)^2 \frac{1}{\sqrt{\left(w + \frac{\sigma^2}{w}\right)^2 - h^2}}\left(\frac{h^2}{\left(w + \frac{\sigma^2}{w}\right)^2 - h^2}\right)\right]
\end{aligned} \tag{I128}$$

6.- Velocity Components in the Crossflow Plane Due to Pitch and Bank of a Monoplane Midwing Mounted on a Body of Elliptical Cross Section

The sketch below shows a monoplane wing mounted on a body with elliptical cross section. The upwash is $V_\infty \sin \alpha$ and the sidewash is $V_\infty \sin \beta$ in the negative x-direction.



Consider the transformation of the wing-body combination into a circle of radius R in the ζ plane as described in section 5.1. For the pitch flow, the complex potential in the ζ plane is:

$$W_\alpha(\zeta) = - i V_\infty \sin \alpha \left(\zeta - \frac{R^2}{\zeta}\right) \tag{I129}$$

The velocity in the Z plane is then

$$v_\alpha - iw_\alpha = \frac{dw}{dZ} = \frac{dw_\alpha}{d\zeta} \frac{d\zeta}{dZ}$$

or

$$v_\alpha - iw_\alpha = i V_\infty \sin \alpha \left(1 + \frac{R^2}{\zeta^2}\right) \frac{d\zeta}{dZ} \tag{I130}$$

For the sideslip flow the complex potential in the ζ plane is

$$W_\beta(\zeta) = -\, i\, V_\infty \sin\beta\, e^{-i\frac{\pi}{2}} \left(\zeta - \frac{R^2 e^{i\pi}}{\zeta}\right)$$

$$= -\, V_\infty \sin\beta \left(\zeta + \frac{R^2}{\zeta}\right) \tag{I131}$$

The associated velocity components in the Z plane are given by

$$v_\beta - i w_\beta = -\, V_\infty \sin\beta \left(1 - \frac{R^2}{\zeta^2}\right) \frac{d\zeta}{dZ} \tag{I132}$$

7.- Velocities on a Vortex Due to Other Vortices in the Presence of a Monoplane Midwing Mounted on a Body of Elliptical Cross-Section Including Effects of Angles of Pitch and Sideslip

We follow the same conformal transformation described in section 5.1. The complete potential for the flow in the ζ plane is

$$W[\zeta(Z)] = -\, i\, V_\infty \sin\alpha \left(\zeta - \frac{R^2}{\zeta}\right) + V_\infty \sin\beta \left(\zeta + \frac{R^2}{\zeta}\right)$$

$$- \frac{i}{2\pi}\Gamma_0\, \ell n \left(\frac{\zeta - \zeta_0}{Z - Z_0}\right) + \frac{i}{2\pi}\Gamma_0\, \ell n \left(\zeta - \frac{R^2}{\bar{\zeta}_0}\right)$$

$$- \frac{i}{2\pi} \sum_{j=i}^{N} \Gamma_j\, \ell n \left(\frac{\zeta - \zeta_j}{\zeta - \dfrac{R^2}{\bar{\zeta}_j}}\right) \tag{I133}$$

and the velocity at Z_0 is:

$$v_0 - i w_0 = -\, i\, V_\infty \sin\alpha \left(1 + \frac{R^2}{\zeta_0^2}\right) \frac{d\zeta}{dZ}\bigg|_{Z_0} + V_\infty \sin\beta \left(1 - \frac{R^2}{\zeta_0^2}\right) \frac{d\zeta}{dZ}\bigg|_{Z_0}$$

$$- \frac{i\Gamma_0}{4\pi} \frac{dZ}{d\zeta}\bigg|_{Z_0} \frac{d^2\zeta}{dZ^2}\bigg|_{Z_0} + \frac{i\Gamma_0}{2\pi} \frac{\bar{\zeta}_0}{\zeta_0\bar{\zeta}_0 - R^2} \frac{d\zeta}{dZ}\bigg|_{Z_0}$$

(equation continued on next page)

$$- \frac{i}{2\pi} \sum_{j=1}^{N} \Gamma_j \left[\frac{1}{\zeta_0 - \zeta_j} - \frac{\bar{\zeta}_j}{\zeta_0 \bar{\zeta}_j - R^2} \right] \frac{d\zeta}{dZ}\bigg|_{Z_0} \tag{I134}$$

The derivatives $\frac{dZ}{d\zeta}$ and $\frac{d^2\zeta}{dZ^2}$ are given in section 5.3.

8.- Velocity Components in the Crossflow Plane Due to Expansion of a Body With Elliptical Cross Sections

Assume that the expansion occurs with constant a/b ratio. Equation (4-30) of reference 8 gives the desired complex potential

$$W_1(Z) = \frac{S'}{2\pi} \ell n \frac{Z + \sqrt{Z^2 - a^2 + b^2}}{2} \tag{I135}$$

$$S = \pi ab$$

$$a = a(x)$$

$$b = b(x)$$

If $\frac{a}{b} = 1/k$ then $S = \pi k a^2$ and $S' = 2\pi k a a' = 2\pi k a \frac{da}{dx}$.

Carrying out the differentiation yields the velocity components.

$$v - iw = \frac{dw}{dZ} = \frac{S'}{2\pi} \frac{2}{Z + \sqrt{Z^2 - a^2 + b^2}} \left(\frac{1}{2} + \frac{2Z}{2(2)\sqrt{Z^2 - a^2 + b^2}} \right)$$

$$= \frac{S'}{2\pi} \frac{1}{Z + \sqrt{Z^2 - a^2 + b^2}} \left(\frac{\sqrt{Z^2 - a^2 + b^2} + Z}{\sqrt{Z^2 - a^2 + b^2}} \right)$$

$$= \frac{S'}{2\pi} \frac{1}{\sqrt{Z^2 - a^2 + b^2}} \tag{I136}$$

APPENDIX J

DESCRIPTION OF PROGRAM DEMON2

The purpose of this appendix is to describe the supersonic lifting surface-body computer program in sufficient detail to permit understanding and use of the program. The present program is an extended and improved version of a pre-existing wing-body program as described in section 1 of this report.

Program DEMON2 computes pressure distributions on lifting surfaces and along the meridians of the body if it is circular in cross section. In this case, the program is equipped with body nose shed vorticity data modeled by two symmetric, discrete potential flow vortices. The effects of this vorticity are accounted for in the calculation of pressures on the body and lifting surfaces. If the body is elliptical in cross section, program WDYBDY described in Appendix K is employed to model the body and to compute pressures acting on it. Program WDYBDY also serves as a companion to DEMON2 for the purpose of calculating body induced velocities at the control points on the lifting surfaces through an exchange of data sets. The lifting surfaces can be cruciform canard fins or cruciform tail fins, a monoplane wing or interdigitated tail fins. For all but the last case, edge vorticity characteristics are calculated by the program.

By repeated application, program DEMON2 in conjunction with other programs can be employed to handle complete configurations including forward and tail lifting surfaces mounted on bodies with circular or elliptical cross section. Detailed descriptions of the required procedures are given in section 5.

The theoretical basis of program DEMON2 and its usage will first be summarized. Configuration parameters taken into consideration are listed. The general calculation procedure is given and it is followed by a description of the program operation. Program limitations and precautions are pointed out. The input required and the output generated by the program are described. Program listings appear at the end of this appendix.

Program Description

Fundamentally, the program is based on representing the lifting surfaces by constant u-velocity panels and the body with circular cross section by a distribution of line sources/sinks and doublets along its centerline. Fin or wing thickness effects are modeled by planar source panels. The body source/sink and doublet strengths are determined explicitly from the flow tangency condition at points on the body surface. The body singularities and body nose vorticity, if applicable, induce velocity components at points on the lifting surfaces. The strengths of the constant u-velocity panels associated with the lifting surfaces and those laid out in a shell around the body to account for interference are obtained from a set of simultaneous equations which result from applying the flow tangency condition at a finite set of control points distributed over the lifting surfaces and interference shell. Thus, mutual interference between one lifting surface and another and between the lifting surfaces and the body are fully accounted for. Further details are given in section 2 and 3 of this report.

If the body is elliptical in cross section, a companion program designated WDYBDY, described in Appendix K, models the body using body source panels. In the main routine CRFWBD of program DEMON2, the effects induced by the body source panels and body nose vorticity, if applicable, are included in the flow tangency condition applied at points on the lifting surfaces. The program has been arranged to allow for an interference shell with elliptical cross section. The lifting surfaces attached to this shell can be a monoplane wing or a set of interdigitated tail fins. Mutual interference is accounted for in the manner described above. Refer to section 4 for more detail.

In the case involving an axisymmetric body, the program first treats the forebody and the forward or canard-body section. Effects of body nose vortices can be included in the calculation of pressures on the body and fins. The afterbody and tail fins are treated by another application of this program. Effects of body nose vortices and the canard edge vortices can be included in the calculated pressures acting on the aft body and loads on the tail fins. A separate program VPATH2, based on slender-body theory and described in Appendix L, is employed to determine the vortex paths along the complete configuration from the leading edge of the canard section back to the body base. The required procedure is described in section 5.1.

When the body is elliptical in cross section, the program first treats the forward or monoplane wing-body section. The forebody is handled by program WDYBDY. Effects of body nose vortices can be accounted for in the calculation of pressures on the body and the monoplane wing. The part of the body between the monoplane wing and tail section is handled also by program WDYBDY. The interdigitated tail-body section is treated by another application of program DEMON2. Effects of body nose and monoplane wing edge vortices can be included in the calculated pressures acting on the afterbody and on the interdigitated tail fin-body section. A separate program VPATHL, based on slender-body theory and described in Appendix L, is used to track vortices from the leading edge of the monoplane wing section to the leading edge of the interdigitated tail section. Section 5.2 describes the required procedure in detail.

As far as the lifting surface sections are concerned, program DEMON2 computes pressure distributions, forces and moments including effects of external vortices, if applicable. The pressures on the fins or wing are calculated on the basis of linear and Bernoulli pressure relationships. For all cases except those including interdigitated tails, leading- and side-edge suction distributions are calculated for the purpose of modeling separation vorticity characteristics at these edges using Polhamus' analogy as described in Appendix C. At the trailing edges, one or more concentrated vortices are computed from the span load distribution using the method described in Appendix B.

Two calculative examples are described in section 6. It should be noted here that the program can also treat wings or fins alone. However, axisymmetric bodies alone cannot be handled. In the latter case, the program can still be used to obtain forebody pressures by including a set of artificial lifting surfaces at the base of the body of interest. Note that the program WDYBDY treats bodies alone. However, in the application of WDYBDY to axisymmetric bodies, computation time far exceeds the time required by program DEMON2 on account of the different type and number of singularities used to represent the body.

Geometrical Characteristics

Program DEMON2 contains the subroutines required to flow model bodies with circular cross section. The body is composed of a nose section followed by a cylindrical section. The nose section may have the following shapes (the choice is set by control index BCODE in namelist $BODY read in by subroutine BDYGEN):

		Forebody Shape
BCODE	= 0	Parabolic
	= 1	Sears-Haack*
	= 2	Tangent-ogive
	= 3	Ellipsoidal
	= 4	Conical

The geometrical characteristics of the lifting surfaces that can be accounted for include the following:

Leading-edge shape:	Straight line which may be swept or it can be composed of straight line elements with different sweeps.
Trailing-edge shape:	Straight line which may be swept or it can be composed of straight line elements with different sweeps.
Thickness:	Accounted for by specifying streamwise slopes (not applicable to interdigitated tails).
Taper:	Uniform or broken.
Mean camber surface:	Planar.
Side edges:	Streamwise (not essential).
Dihedral:	Arbitrary, set by angle PHIDIH (see figure 3).
Location of interference shell:	Arbitrary, set by angle THETIT (see figure 3).

The lifting surfaces can be cruciform canard fins, cruciform tail fins, a monoplane wing or a set of interdigitated tails. In all instances, there must be a vertical plane of symmetry ($y_B = 0$ plane) as far as the geometry is concerned.

*Ashley, H. and Landahl, M.: Aerodynamics of Wings and Bodies, Addison-Wesley Publishing Co., Inc., 1965, pp. 180-181.

APPENDIX J

Calculation Procedure

Program DEMON2 proceeds through various stages as follows. After reading in the run identification, namelist $INPUT is read in by main routine CRFWBD. Basically, this list contains wing or fin geometry data, flow conditions, geometry specifications for the interference shell and specifications for the distribution of constant u-velocity panels on the fin and the shell. In addition, moment-center coordinates and the vortex lift factors are specified. The wing- and body-coordinate systems are shown in figures 1 and 2.

The wings or fins of any fin-body combination are covered with a constant u-velocity panel layout with the panel side edges parallel to the fin root chords which, in turn, are made to be parallel to the body centerline. An optional input allows for unequal spanwise spacing of the side edges and breaks in sweep. The actual construction of the panel sweeps, centroid and control point coordinates is performed in subroutine LAYOUT. All coordinates are expressed in the x_w, y_w, z_w or wing coordinate system. Coordinate transformations relating a fin coordinate system with origin on the fin rootchord to the wing coordinate system are implemented in subroutine LAYOUT by means of function statements FYROT and FZROT. Subroutine LAYOUT also computes the geometrical characteristics of the body interference panels. Note that the leading and trailing edges of the interference panels are unswept, see figure 1.

As an option, the above process is repeated in subroutine THKLYT for the layout of planar source panels. They are used to account for thickness associated with the wings or fins of a cruciform, planar but not an interdigitated configuration such as the combination shown in figure 3. Streamwise thickness slopes are read in by subroutine THKIN. Depending on the procedural steps described in section 5, main routine CRFWBD can write a data set containing the coordinates, in the wing coordinate system, of the control points associated with the wings or fins and the interference shell. If control index NCPOUT is set equal to 2 in namelist $INPUT, the run is stopped at this stage. Otherwise, the program continues as follows.

If the body is circular in cross section, main routine CRFWBD calls subroutine BDYGEN. This subroutine proceeds to read in namelist $BODY which contains body nose length and length of body to be modeled as well as control indices governing the number of line singularities distributed along the body centerline and the shape of the body nose. The layout and strengths of the line sources/sinks and line doublets employed to flow model the body are then computed for the flow conditions read in by namelist $INPUT. Main routine CRFWBD then calls subroutine BDYPR which computes pressure distributions at points along the meridians on the body with circular cross section. The Bernoulli pressure, equation (10), is used for this purpose on this process, effects of body nose vorticity and body line singularities are accounted in the pressures calculated on the forebody. Over the length of body covered by the lifting surfaces, the pressures are computed at the control points of the body interference panels in the interference shell. This is performed following entry point BDYAFT after the panel strengths are calculated. The velocity components used in the pressure calculation include contributions from the body line singularities, external vortices and constant u-velocity and source panels distributed over the fins or wings. The effects of external vortices (such as body nose vortices) can be accounted for on the basis of the vortices moving parallel to the body centerline (subroutine VRTVEL) or the vortices moving in the crossflow plane (program VPATH2 or VPATHL). Subroutine BDYPR also calculates the pressures on the length of body between the forward and aft lifting surface sections.

Velocity components induced by line singularities associated with the axisymmetric body at the control points on the lifting surfaces and interference shell are calculated by subroutine VELCAL. These components will be used in the flow tangency condition applied at points on the lifting surfaces and in the calculation of pressures at points on the lifting surfaces and the interference shell.

For cases involving bodies with elliptical cross sections, main routine CRFWBD calls subroutine BDYRD which reads in velocity components induced by the body source panels at the control points distributed over the lifting surfaces and interference shell. These velocities will be used in the flow tangency condition applied at the control points on the lifting surfaces and the calculation of pressures at points on the lifting surfaces and the interference shell.

Routine CRFWBD continues with the construction of the influence coefficient matrix associated with the constant u-velocity panels laid out on the lifting surfaces and the interference shell. In this process, subroutine VELNOR performs the superposition of 4 corner solutions associated with a trapezoidal, constant u-velocity panel. For each corner subroutine VELO computes the influence of a semi infinite triangle. If the flow conditions dictate symmetry in loading (w.r.t. the y_B (or y_W) = 0 plane), subroutine VELNOR also accounts for the influence of the constant u-velocity panels on the opposite side of the plane of symmetry. Appendix A contains a discussion concerning the superposition scheme and the symmetry account.

The aerodynamic influence matrix, designated FVN, consists of the left-hand sides of equations (1) through (5) in section 3.4 and is triangularised by subroutine LINEQS. The right-hand sides of these equations are formed as a single column matrix designated RHS. For the control points on the lifting surfaces, the latter contains contributions from the free stream (including effect of deflection angle), body singularities (line singularities or source panels) and external vortices if applicable. For the control points on the interference shell, the right-hand side only contains contributions from the planar source panels modeling thickness of the lifting surfaces. These contributions are calculated by a call to subroutine THKVEL. Note that thickness effects are not accounted for if the lifting surfaces are interdigitated tails.

In the determination of velocity components normal to the panels on the lifting surfaces, transformations from the reference or wing coordinate system to the fin coordinate system are required. Subroutine ROTATE with entry points ROTWF and ROTFW contains the rotational coordinate transformation described in Appendix D. These transformations are used in the determination of normal velocity components as indicated in Appendix E and apply to cruciform, monoplane and interdigitated lifting surface configurations. Likewise, velocity transformations are performed from the reference or wing coordinate system to the local body interference panel coordinate system. These transformations are performed in subroutine TRBIPW with entry points TRWBIP (for coordinates), ROTBW and ROTWB (for velocities). The angles associated with the transformations are indicated in figure 3. The velocity transformations apply to both the left- and right-hand sides of equations (1) through (5).

Main routine CRFWBD then calls subroutine SOLVE which takes the triangulated aerodynamic influence coefficient matrix, FVN, generated by LINEQS and the single column matrix, RHS, and proceeds to solve for the unknown strengths of the constant u-velocity panels.

Subroutine LOADS is then called to compute forces and moments acting on the lifting surfaces and the interference shell. Transformations from the local fin or body interference panel coordinate system to the reference or wing coordinate system are performed for the force and moment coefficients. For example, the force acting normal to the fins must be resolved into the y_W or y_B and z_W or z_B directions associated with the wing or body coordinate systems. The procedure is described in Appendix F. Note that the force and moment transformations also apply to monoplane or cruciform lifting surface configurations. The forces and moments are calculated in the body coordinate system and then transformed into the wind axis coordinate system in accordance with equations (18) and (19). These equations appear in section 4.2 in connection with calculations performed in program WDYBDY and apply to subroutine LOADS of program DEMON2 as well.

The loads acting on the interference shell calculated by subroutine LOADS represent only the lift carryover from the lifting surfaces to the body and may include interference due to fin or wing thickness. The pressures acting on the interference shell calculated by subroutine BDYPR (through entry point BDYAFT) include effects not only from the lifting surfaces but also include contributions from body singularities and external vortices if applicable. As such the pressures are indicative of the total load acting on the body over the length covered by the lifting surfaces.

Subroutine LOADS calculates the fin and interference shell loads first on the basis of linear pressure. This is followed by a call to subroutine SPECPR from subroutine LOADS to compute pressures acting on the lifting surfaces using the Bernoulli pressure equation (10). The loads acting on the lifting surfaces are then recalculated on the basis of the Bernoulli pressures.

If the lifting surfaces do not form an interdigitated fin configuration, subroutine LOADS calls subroutine SPNLD for the purpose of calculating spanload distributions, leading- and side-edge suction distributions. Using the span loading information, the strength and spanwise location of the concentrated trailing-edge vortices are calculated in accordance with Appendix B. The vorticity characteristics associated with the leading and side edges are determined from the suction distributions as described in Appendix C.

Program Operation

The cruciform wing-body computer program is written in the FORTRAN IV language (029 punch) and has been run on the CDC 6600 machine belonging to Boeing Computer Services, Inc. The main program is arranged so that a total of 250 constant u-velocity panels is available to cover the wing surfaces and to be used as body interference panels. A total of 100 sources and 100 doublets can be used to model the body. If the program is to be run on a different computer with smaller core memory, dimension statements need to be changed to permit operation on that machine.

In addition to the standard input and output tapes (TAPE5=INPUT, TAPE6=OUTPUT), the program may require additional devices such as disc files or tapes for storing data sets generated when certain options are used. One data set would consist of a set of control point coordinates and the other would contain a set of perturbation velocities. Devices used for these purposes are TAPE4 and TAPE7. The program employs a system-supplied subroutine REQFL which computes the actual dimension requirement for the aerodynamic coefficient matrix FVN. This subroutine makes use of special machine-dependent parameters. Certain other systems may have a similar subroutine available. If no such subroutine is available, the dimension of array FVN should be set to 62,500 and the four calls to REQFL marked in the main program removed.

Additional system-supplied devices used by the main program are the BUFFER OUT and BUFFER IN options. They are used as an option to save the triangulated aerodynamic influence matrix FVN associated with the fins and body interference shell. TAPE3 is used for this purpose. This procedure saves time when calculations are done for a given configuration at some Mach number but with different included angles of attack or roll.

However, the pertinent calls should be removed from the main program if other systems do not offer such devices.

Program DEMON2 treats one set of lifting surfaces on a body. In order to handle complete configurations involving forward and tail lifting surfaces, the program must be used in a stepwise manner in conjunction with other programs described in this report. A detailed description of the required procedure is given in section 5.

Running time required by program DEMON2 is governed by the number of constant u-velocity panels laid out on the lifting surfaces. For a pitched and rolled cruciform wing-body combination employing 192 constant u-velocity panels and 22 sources/sinks and doublets, the running time on the CDC 6600 is about 60 seconds for one set of flow conditions.

Program Limitations and Precautions

There are some problems that could arise in the use of the cruciform wing-body program. It should be noted that subroutines LOADS, BDYPR, VRTVEL, ROTATE and TRBIPW contain entry points. The first does not employ an argument list and should not cause any problems. However, the entry points in the second, third, fourth and fifth may need to have the appropriate subroutine argument list attached to them if other computer machines are used.

A warning is concerned with the use of system subroutine REQFL and the BUFFER devices already mentioned above under program operation. If the subroutine is not available, an equivalent subroutine can be called or the calls to REQFL can be removed and the dimension on FVN set to 62,500. Similarly, if the BUFFER devices are not system supplied, calls to them in the main program should be removed.

In the specification of the number of constant u-velocity panels to be distributed on the fins and body in namelist $INPUT, the following limits must be kept in mind. For the fins, a maximum of 150 panels are available. In the spanwise direction, the maximum number of panels is 19. The number of body interference panels must not exceed 100. Finally, the total number of panels on the fins and interference shell cannot exceed 250. In namelist $BODY, the number of sources/sinks and the number of doublets (both specified by NXBODY) cannot exceed 100.

Care must be taken with the use of control indices NOUT and NPR. A very large amount of additional output is generated when these indices are set equal to one. This output should only be used for debugging purposes employing a minimum number of constant u-velocity panels such as two per fin and four on the circumference of the body interference shell with two in the lengthwise direction.

A maximum magnitude is set by the program for the perturbation velocities induced by external vortices at the control points in the flow tangency condition. Since these velocities are based on potential vortex theory, their values could assume large magnitudes if the vortices run close to the fins and cause undue influence. Consequently, their magnitude is limited to 0.35. This value can be overridden by setting variable VRTMAX in namelist $INPUT equal to the desired value.

At the present time, program DEMON2 computes pressure distributions on the body surface and lifting surfaces of complete configurations in conjunction with other programs as described in section 5. The program also determines the force and moment coefficients associated with the lifting surfaces but it does not compute the forces and moments acting on the body if it is circular in cross section. The latter quantities can be determined by an integration of the program calculated pressure distributions. In this connection, the program calculated forces and moments associated with the interference shell only represent the effects of lift carryover from the lifting surfaces to the body although effects of thickness may be included. The actual loads acting on the part of the body in the lifting surface section can also be determined from the pressure distributions.

Span load and suction distributions and the associated edge vorticity characteristics are not calculated for interdigitated fins at this time. Thickness effects are also not accounted for this type of lifting surface configuration.

Description of Input

This section describes the input for program DEMON2 for treating one set of lifting surfaces on a body. In the following discussion, the content of all input cards is summarized. All possible input variables are listed at the end of this section in the order of appearance in the input deck, except for the first four variables which do not appear in the input deck but are needed for program input preparation. Sample inputs are discussed in section 6 concerned with the calculative examples. Note that the correspondence in designation between interdigitated fins and cruciform fins is indicated in figure 3 and also referred to in item 2 below.

Item 1

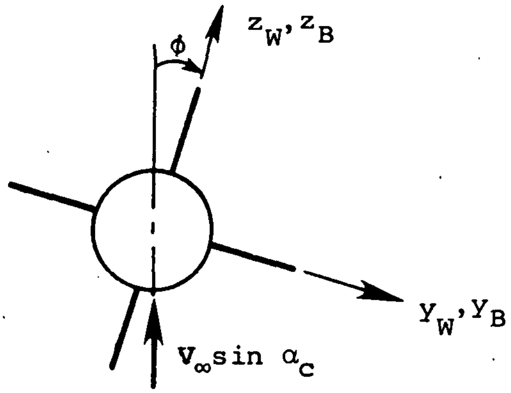
The first card serves as identification and may contain any alphanumeric information desired. This information is printed on the first page of the output.

Item 2

The second and following cards form the namelist $INPUT which specifies the geometrical parameters of the wing surfaces and interference shell. These parameters are the leading-edge and trailing-edge sweeps, semispan and rootchord. For a planar wing or cruciform wing alone, the rootchord is the wing centerline or the cruciform wing junction. In the case of a wing-body combination, the rootchord is the line formed by the junction of the lifting surface and the body. The semispan is measured from the rootchord in any case.

This namelist also contains the deflection angles and the number of chordwise and spanwise constant u-velocity panels for each lifting surface. The spanwise number may differ from one fin to another but the chordwise number NCW is the same for all. Similar information is specified for the layout of planar source panels. The number of body interference panels, NBDCR, on the circumference are also included in this namelist. The specification of the latter also determines whether or not a body is present. The number of body interference panels in the axial direction is specified by NCWB. The body can be cylindrical or elliptical in cross section over the interference length, BIL, spanned by the lifting surfaces. If the interference shell is elliptical, the horizontal semi-axis RB and vertical semi-axis RA must be specified. The ratio RB/RA must equal ERATIO. If the interference shell is circular, set RB equals RA and ERATIO equals 1. If the lifting surfaces are delta wings (unswept trailing edges), length BIL equals the rootchord CRP. If the trailing edges are swept back, the length BIL should be extended to include the trailing edge of the tip chord to account properly for the interference of the lifting surfaces on the body.

The included angle of attack, ALFAC, is the angle between the free stream and the body/wing centerline (x_B-axis in figure 1). Angle of roll, PHI, is indicated by ϕ in the sketch below. The program computes pitch and sideslip angles in accordance with the pitch-roll transformation mentioned in section 4 of this report.



Setting control index NDRAG equal to 1 results in the calculation of in-plane forces (Appendix C) acting on the lifting surfaces. At the present time, this is not possible when the lifting surfaces form an interdigitated configuration and NDRAG should be set equal to 0 (the default value) for this case.

In addition, more control indices, free-stream Mach number, and reference quantities SREF and REFL are read in. Breaks in leading-edge and/or trailing-edge sweeps are also allowed if the configuration is a wing or cruciform wing alone at zero sideslip or if the configuration consists of a monoplane or cruciform or interdigitated wing-body. This option is governed by control index LVSWP. Angles SWLEP, SWTEP, SWLEV, and SWTEV need not be specified if LVSWP $\neq$ 0.

Indices NCPOUT, NVLIN, ITAIL, JCPT play an important part in the procedural use of program DEMON2 as described in section 5 in this report. Quantities FKLE and FKSE are the vortex lift factors discussed in Appendix C. The axial location of the moment center, XM, must be specified in the body coordinate system with origin at the nose.

Angles PHIDIH and THETIT are indicated on figure 3 and apply to monoplane and interdigitated lifting surface configurations. Note that the correspondence in designation between interdigitated fins and cruciform fins is indicated in figure 3. It is also referred to in connection with the fin deflection angles listed under item 2.

Item 3

This optional input is required when there are breaks in the wing sweep or if the constant u-velocity panel side edges are to be laid out with user-determined unequal spanwise spacings. This input pertains only to a wing or cruciform wing alone at zero sideslip. Variable YR is the distance from the rootchord to the outboard panel side edges. Therefore, the first value for YR is zero. The last value for YR must equal wing semispan, B2, specified in the namelist $INPUT. In effect, this specification positions the panel outboard side edges on the right wing. The sweep angles are positive for wings with sweptback leading and trailing edges.

Item 4

The optional input of this item is associated with a wing-body combination with breaks in leading-edge and/or trailing-edge sweeps. Also, this input should be used for this configuration if the constant u-velocity panel side edges are to be laid out with user-determined unequal spacings. Variable YRT is the distance from the wing rootchord to the outboard constant u-velocity panel edges on the right wing or fin. The first value should equal 0.0 and the last value for YRT equals the semispan, B2; the latter is specified in the namelist $INPUT. The sweep angles are positive for right wings or fins with sweptback leading and trailing edges.

Item 5

This optional input accompanies Item 4 and is associated with the left wing or fin. Variable YLT is the distance from the wing rootchord to the outboard constant u-velocity panel edges on the left wing or fin. The first value should equal 0.0 and the last value for YLT equals the negative semispan, -B2. The sweep angles are negative for left wings or fins with sweptback leading and trailing edges.

Item 6

The information in this optional item accompanies Items 4 and 5 if the configuration is a cruciform or interdigitated wing-body combination. Again, this input should only be used if there are breaks in the wing or fin sweeps or if the panel side edges are to be laid out with user-determined unequal spacings. Variable ZUT is the distance from the wing rootchord to the outboard constant u-velocity panel edges on the upper wing or fin. The first value should equal 0.0 and the last equals the semispan, B2V. The latter is specified in namelist $INPUT. The sweep angles are positive for upper wings or fins with sweptback leading and trailing edges.

Item 7

This optional information is the last of four inputs associated with a cruciform or interdigitated wing-body combination if there are breaks in sweep or if the constant u-velocity panel side edges are to be laid out with user determined spacings; see Items 4 through 6. Variable ZDT is the distance from the wing rootchord to the outboard constant u-velocity panel edges on the lower wing or fin. The first value should equal 0.0 and the last value for ZDT must equal -B2V. The sweep angles are negative for lower wings or fins with sweptback leading and trailing edges.

Item 8

This item is concerned with the specification of the layout and strengths of the planar source panels employed to model thickness of the lifting surfaces. If the case at hand involves interdigitated lifting surfaces, this item must be omitted in the input (NTDAT=0). Basically, the planar source panels are laid out in the same manner used to layout the constant u-velocity panels. However, in this case the distance out to the outboard panel edge is now measured from the body centerline not the rootchord of the lifting surface under consideration. Breaks in sweep are handled by control index LVSWT in the same way control index LVSWP handled breaks in sweep in the layout of constant u-velocity panels.

The strengths of the planar source panels are related directly to the streamwise slopes and must be specified a priori. An example of such a specification is shown in section 6.2. Note that quantity THET is in fact the tangent of the thickness envelope angle, tan θ_s.

Item 9

The input cards for this item form the namelist $BODY which is required only when a body with circular cross section is part of the configuration under consideration. If the integer NBDCR in namelist $INPUT under Item 2 is specified to be nonzero, and RB equals RA, a body with circular cross section is present. The information in this input includes specification of body geometry parameters and is read in by subroutine BDYGEN. The length of the nose, LNOSE, determines the body length over which the radius is changing as a function of the body axial coordinate. The actual nose configuration is governed by control index, BCODE, which selects preprogrammed forebody shapes described above in this appendix.

Normally, the body length, LBODY, should at least equal the axial distance from the body nose to the trailing edges of the lifting surfaces under consideration. If the trailing edges are sweptback, length LBODY should be taken to include the trailing edge of the tip chords or side edges of the lifting surfaces at hand.

The minimum number of body modeling singularities NXBODY should be determined as follows. Let the density (sources and doublets/unit body length) be determined by the number of constant u-velocity panels in the chordwise direction on the wing divided by the rootchord (or length of wing-body junction). Then, number NXBODY equals the density times body length.

Item 10(a)

This input is required only when variable NVRTX specified in namelist $INPUT, Item 2, is nonzero and if the body is circular in cross section. In fact, NVRTX is the number of external, two-dimensional vortices whose influences are to be included in the pressure and loading calculations. Each vortex is assumed to be infinite in length and to be parallel to the body centerline. Therefore, with each vortex there is associated a nondimensional strength, GAMMA, and nondimensional crossflow plane coordinate, YVRTX, ZVRTX, given in the body or wing coordinate system shown in figure 1. These quantities are input in subroutine VRTVEL.

Item 10(b)

This input is required only when variable NVRTX specified in namelist $INPUT, Item 2, is nonzero and if the body is elliptical in cross section. As in item 10, each vortex is assumed infinite in length and to be parallel to the body centerline. In this case, the strength GAMMA is Γ/V_∞, and YVRTX and ZVRTX are the coordinates expressed in the wing coordinate system for each vortex. This information is read in by main routine CRFWBD.

Items 11, 12, 13, 14

The information specified in these items pertain to leading- and side-edge vorticity characteristics. If specified in the input, their influence would influence the pressures and loads on the lifting surfaces and the interference shell under consideration. Presently, it is not recommended to include edge vorticity effects associated with a lifting surface in the calculation of the loading acting on the same lifting surface. Thus, a blank card can be inserted for items 11 and 13.

Item 15

This card ends the process of reading in data for program DEMON2. It should only be put at the end of all data cards for the case(s) to be run. The computer program stops the search for more data and the run is finished.

INPUT VARIABLES, PROGRAM DEMON2

The terms "right and "left" refer to an observer looking forward.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
MSWRP	Definitions of terms used below	(Number of chordwise rows on right wing) + 1; MSWRP = MSWR + 1.
MSWLP		(Number of chordwise rows on left wing) + 1; MSWLP = MSWL + 1.
MSWUP		(Number of chordwise rows on upper wing) + 1; MSWUP = MSWU + 1.
MSWDP		(Number of chordwise rows on lower wing) + 1; MSWDP = MSWD + 1.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
Item 1	(20A4)	Any alphanumeric information may be put on this card for identification of the calculation.
Item 2		Namelist $INPUT.
CRP	$c_{r,H}$	Horizontal wing rootchord, dimensional.
SWLEP	$\Lambda_{LE,H}$	Horizontal wing leading-edge sweep angle measured in wing planform, positive for sweep back, degrees.
SWTEP	$\Lambda_{TE,H}$	Horizontal wing trailing-edge sweep angle measured in wing planform, positive for sweep back, degrees.
NCW		Number of chordwise constant u-velocity panels on the wing.
MSWR		Number of spanwise constant u-velocity panels on right wing; $1 \leq$ MSWR ≤ 19.
MSWL		Number of spanwise constant u-velocity panels on left wing; $1 \leq$ MSWL ≤ 19, default is 0.
MSWU		Number of spanwise constant u-velocity panels on the upper wing; $1 \leq$ MSWU ≤ 19, default is 0.
MSWD		Number of spanwise constant u-velocity panels on the lower wing; $1 \leq$ MSWD ≤ 19, default is 0. Note: When running symmetric case do not include vertical surfaces. Set NCRX = 0 MSWL = 0 MSWU = 0 MSWD = 0
SWLEV	$\Lambda_{LE,V}$	Vertical wing leading-edge sweep angle measured in wing planform positive for sweep back, degrees, default is 0.0.
SWTEV	$\Lambda_{TE,V}$	Vertical wing trailing-edge sweep angle measured in wing planform, positive for sweep back, degrees, default is 0.0.
CRPV	$c_{r,V}$	Vertical wing rootchord, dimensional, default is 0.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
B2	$b_H/2$	Exposed horizontal wing semispan, dimensional.
B2V	$b_V/2$	Exposed vertical wing semispan, dimensional, default is 0.0.
RA	b	Vertical semi-axis for body with elliptical cross section.
RB	a	Horizontal semi-axis for body with elliptical cross section.
ERATIO	a/b	Ratio of RB over RA Note: If body has circular cross section set RA = RB and ERATIO = 1.0.
BIL		Length of body influenced by fins to account for interference. For fins with delta planform and for wing-alone cases, BIL = CRP.
NFVNPR		NFVNPR $\neq$ 0 Print influence coefficient matrix FVN for debugging, default is 0.0.
NOLINP		NOLINP = 0 Loadings calculated on the basis of linear pressures only, default value. NOLINP = 1 Loadings calculated on the basis of linear and Bernoulli pressures.
NOUT		NOUT $\neq$ 0 Print large amount of output for debugging, default is 0.0.
NPR		Same as NOUT, default is 0.0.
NDRAG		NDRAG = 0 Omit calculation of in-plane forces, default value. NDRAG = 1 Include calculation of in-plane forces. Use default value when treating interdigitated tails.
FAC		FAC = 0.95 Fraction of the constant pressure panel chord (which contains the centroid) where the control point is located.
TOLFAC		TOLFAC = 1 Multiplication factor used in the evaluation of the tolerance, TLRNC, used in subroutine VELO.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
NPRESS		NPRESS = 0 This value insures that loadings are also computed on the basis of the linear pressure relationship in addition to the Bernoulli pressure relationship.
VRTMAX		Maximum magnitude of vortex induced velocities included in flow tangency condition, default is 0.35.
NVRTPL		NVRTPL = 0 Component of velocity parallel to fin induced by vortices not included in Bernoulli loading pressure, default value. NVRTPL = 1 Loading pressure calculated including parallel component of vortex induced velocity.
NAGAIN		NAGAIN = 0 No use made of buffer to save aerodynamic influence matrix, FVN, after triangulation, default value = 0. NAGAIN = 1 Buffer out FVN array. For succeeding runs, keep NAGAIN = 1.
DELR	$\delta_{H,R}$	Deflection angle of horizontal right wing. Positive: trailing edge down, degrees, default is zero.
DELL	$\delta_{H,L}$	Deflection angle of horizontal left wing, Positive: trailing edge down, degrees, default is 0.0.
DELU	$\delta_{V,U}$	Deflection angle of vertical upper wing, Positive: trailing edge to right, degrees, default is 0.0.
DELD	$\delta_{V,D}$	Deflection angle of vertical lower wing, Positive: trailing edge to right, degrees, default is 0.0. If case involves <u>interdigitated fins</u>: $\delta_{H,R}$ applies to right upper fin, trailing edge down is positive. $\delta_{H,L}$ applies to left lower fin, trailing edge down is positive. $\delta_{V,U}$ applies to right lower fin, trailing edge down is positive. $\delta_{V,D}$ applies to left upper fin, trailing edge down is positive.
ALFAC	α_c	Included angle of attack, measured between free-stream velocity vector and body/wing centerline.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
PHI	ϕ	Angle of roll, measured from the plane containing the free-stream velocity vector and the body/wing centerline to the upper wing, positive clockwise looking forward, default is 0.0.
FMACH	M_∞	Free-stream Mach number.
LVSWP		LVSWP = 0 No breaks in wing leading or trailing edges, or equal spanwise spacings of panel side edges, default value. LVSWP $\neq$ 0 Up to 19 breaks in wing leading or trailing edges or up to 19 unequal spanwise spacings.
NVRTX		Number of external vortices present, NVRTX $\leq$ 10 (see Item 10(a)).
NCRX		NCRX = 0 Horizontal wing only present, default value. NCRX = 1 Vertical wing surfaces in addition to horizontal wing surfaces present.
NBDCR		Number of constant u-velocity panels on the circumference of the body. NBDCR = 0 No body present, default value. NBDCR > 0 Body present (see Item 8).
NCWB		Number of constant u-velocity panels in the longitudinal direction on the surface of the body over the body interference length BIL, default is 0.0.
SREF	S_{ref}	Reference area used in load calculations, default is 1.
REFL	ℓ_{ref}	Reference length used in rolling-moment calculations, default is 1.
ITAIL		ITAIL = 1 Tail fins to be considered, default is 0. If case involves interdigitated fins mounted on body with elliptic cross section set ITAIL = 0.
NBDYPR		NBDYPR = 1 Pressures to be calculated along body meridians, default is 0.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
NTPR		NTPR = 1 Print debug output from subroutine THKVEL, default is 0.
NTDAT		Number of sets of thickness data to be input. Set NTDAT=0 for cases involving interdigitated fins. NTDAT = 0 No thickness input data, default value. NTDAT = 1 For horizontal wing, symmetric layout <u>or</u> for cruciform wing, symmetric layout with layout on vertical wings same as on horizontal wings. NTDAT = 2 For cruciform wing, symmetric layout. Vertical wing layout different from horizontal <u>or</u> for horizontal wing alone (delta wing) with asymmetric layout. NTDAT = 4 For cruciform wing alone (delta wing), asymmetric layout.
NCWT		Number of source panels in a chordwise row, default is 0.
NCPOUT		NCPOUT = 0 No control point coordinates written, default value. NCPOUT = 1 Write coordinates (in wing coordinate system) of control points on fin and body interference shell in data set (TAPE4), and continue the run. NCPOUT = 2 Write coordinates (in wing coordinate system) of control points on fin and body interference shell in data set (TAPE4) and stop the run (STOP77).
NVLIN		NVLIN = 0 Do not read in velocity components induced by moving vortices. NVLIN = 1 Read in velocities induced by moving vortices (calculated by program VPATH2 or VPATHL) from a data set (TAPE7), default is 0.
XSTART		Axial station aft of which body pressures are to be calculated. If case involves interdigitated tails on body with elliptic cross section, set XSTART = 0.0, default is 0.0.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
JCPT		Number of control points and body pressure points calculated by subroutine BDYPR and printed in output. This number is required when NVLIN = 1 and ITAIL = 1, default is 0.
FKLE		Fraction of leading-edge suction converted into normal force, default is 0.5.
FKSE		Fraction of side-edge suction converted into normal force, default is 0.5.
XM		x-coordinate of moment center in body coordinate system, default is 0.0.
ZM		z-coordinate of moment center in body coordinate system, default is 0.0.
PHIDIH	ϕ_F	Dihedral angle associated with interdigitated fin, default is 0.0, $0 \leq \phi_F < 90°$.
THETIT	θ	Location angle associated with interdigitated fin, default is 0.0, $0 \leq \theta < 90°$.
XWLE		Axial location of wing rootchord leading edge measured from body nose, default is 0.0.
<u>Item 3</u>	(3F10.5)	Optional input for planar or cruciform wing alone at zero sideslip.
YR(KJ)	$y_{W,R}(KJ)$	Distance from wing rootchord to the constant pressure panel outboard side edge on right wing, $1 \leq KJ \leq MSWRP$, ($MSWRP \leq 30$), YR(1) = 0.0, YR(MSWRP) = B2.
VSWLER(KJ)	$\Lambda_{LE,R}(KJ)$	Leading-edge sweep of wing between YR(KJ-1) and YR(KJ), positive for sweep back, degrees, $1 \leq KJ \leq MSWRP$, ($MSWRP \leq 20$), VSWLER(1) = 0.0.
VSWTER(KJ)	$\Lambda_{TE,R}(KJ)$	Trailing-edge sweep of wing between YR(KJ-1) and YR(KJ), positive for sweep back, degrees. $1 \leq KJ \leq MSWRP$, ($MSWRP \leq 20$), VSWTER(1) = 0.0.
<u>Item 4</u>	(3F10.5)	Optional input for wing-body combination.
YRT(KJ)	$y_R(KJ)$	Distance from wing rootchord to the constant u-velocity panel outboard side edge on right wing, $1 \leq KJ \leq MSWRP$, ($MSWRP \leq 20$), YRT(1) = 0.0, YRT(MSWRP) = B2.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
VSWLER(KJ)	$\Lambda_{LE,R}(KJ)$	Leading-edge sweep of wing between (YRT(KJ-1) and YRT(KJ), positive for sweep back, degrees, $1 \leq KJ \leq$ MSWRP, (MSWRP $\leq$ 20), VSWLER(1) = 0.0.
VSWTER(KJ)	$\Lambda_{TE,R}(KJ)$	Trailing-edge sweep of wing between (YRT(KJ-1) and YRT(KJ), positive for sweep back, degrees, $1 \leq KJ \leq$ MSWRP, (MSWRP 20), VSWTER(1) = 0.0.
Item 5	(3F10.5)	Optional input for wing-body combination.
YLT(KJ)	$y_{W,L}(KJ)$	Distance from wing rootchord to the constant u-velocity panel outboard side edge on left wing, $1 \leq KJ \leq$ MSWLP, (MSWLP $\leq$ 20), YLT(1) = 0.0, YLT(MSWLP) = -B2.
VSWLEL(KJ)	$\Lambda_{LE,L}(KJ)$	Leading-edge sweep of wing between YLT(KJ-1) and YLT(KJ), negative for sweep back, degrees, $1 \leq KJ \leq$ MSWLP, (MSWLP $\leq$ 20), VSWLEL(1) = 0.0.
VSWTEL(KJ)	$\Lambda_{TE,L}(KJ)$	Trailing-edge sweep of wing between YLT(KJ-1) and YLT(KJ), negative for sweep back, degrees, $1 \leq KJ \leq$ MSWLP, (MSWLP $\leq$ 20), VSWTEL(1) = 0.0.
Item 6	(3F10.5)	Optional input for cruciform wing-body combination.
ZUT(KJ)	$z_{W,U}(KJ)$	Distance from wing rootchord to the constant u-velocity panel outboard side edge on upper wing, $1 \leq KJ \leq$ MSWUP, (MSWUP $\leq$ 20), ZUT(1) = 0.0, ZUT(MSWUP) = B2V.
VSWLEU(KJ)	$\Lambda_{LE,U}(KJ)$	Leading-edge sweep of wing between ZUT(KJ-1) and ZU(KJ), positive for sweep back, degrees, $1 \leq KJ \leq$ MSWUP, (MSWUP $\leq$ 20), VSWLEU(1) = 0.0.
VSWTEU(KJ)	$\Lambda_{TE,U}(KJ)$	Trailing-edge sweep of wing between ZUT(KJ-1) and ZUT(KJ), positive for sweep back, degrees, $1 \leq KJ \leq$ MSWUP, (MSWUP $\leq$ 20), VSWTEU(1) = 0.0.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
Item 7	(3F10.5)	Optional input for cruciform wing-body combination.
ZDT(KJ)	$z_{W,D}$(KJ)	Distance from wing rootchord to the constant u-velocity panel outboard side edge on lower wing, $1 \leq KJ \leq MSWDP$, $(MSWDP \leq 20)$, ZDT(1) = 0.0, ZDT(MSWDP) = -B2V.
VSWLED(KJ)	$\Lambda_{LE,D}$(KJ)	Leading-edge sweep of wing between ZDT(KJ-1) and ZDT(KJ), negative for sweep back, degrees, $1 \leq KJ \leq MSWDP$, $(MSWDP \leq 20)$, VSWLED(1) = 0.0.
VSWTED(KJ)	$\Lambda_{TE,D}$(KJ)	Trailing-edge sweep of wing between ZDT(KJ-1) and ZDT(KJ), negative for sweep back, degrees, $1 \leq KJ \leq MSWDP$, $(MSWDP \leq 20)$, VSWTED(1) = 0.0.
Item 8		Optional thickness input data when NTDAT $\neq$ 0. If case involves interdigitated fins, this option is not used.
Item 8(a)	(3I5)	Information in items 8(a), 8(b) are read in by subroutine THKIN for the right horizontal wing.
MSWT		Number of source panels in the spanwise direction, $1 \leq 19 \leq MSWT$.
LVSWT		LVSWT = 0 No breaks in wing leading or trailing edges, or equal spanwise spacings of source panel sides, default is 0. LVSWT = 1 Up to 19 breaks in wing leading or trailing edges or up to 19 unequal spanwise spacings.
NUNIS		NUNIS = 1 Thickness distribution varies over the span. NUNIS = 0 Thickness distribution constant over the span.
Item 8(b)	(3F10.0)	Optional input for LVSWT = 1.
YTH(1,J)		Distance from body centerline to the source panel outboard side edge, $1 \leq J \leq MSWT+1$.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
SWLET(J)		Leading-edge sweep of wing between YTH(1,J-1) and YTH(1,J), positive for sweep back, degrees, $1 \leq J \leq$ MSWT+1.
SWTET(J)		Trailing-edge sweep of wing between YTH(1,J-1) and YTH(1,J), positive for sweep back, degrees, $1 \leq J \leq$ MSWT+1.
Item 8(c)	(8F10.0)	Optional input specifying streamwise thickness slopes read in by subroutine THETIN.
THET(K)	$\tan \theta_s$	NUNIS = 1 K = 1, NWCT NUNIS = 0 K = 1, (NCWT*MSWT)
Item 8(d)		Optional input for left wing when body is not present and if geometric yaw angle is accounted for (skewed panels). All input same as for right wing above, items 8(a), 8(b), and 8(c).
Item 8(e)		Optional input for upper wing if NTDAT = 2 or 4 and NCRX = 1. Same input as for right wing, items 8(a), 8(b) and 8(c).
Item 8(f)		Optional input for lower wing if NCRX = 1 and body is not present and if geometric pitch angle is accounted for (skewed panels). All input same as for right wing, items 8(a), 8(b) and 8(c).
Item 9		Namelist $BODY read in by subroutine BDYGEN. Optional input when body with circular cross section is present, NBDCR $\neq$ 0.
NXBODY		Number of line source/sinks and line doublet singularities distributed along body centerline.
LNOSE		Length of nose part of body measured from nose tip, dimensional (real variable).
LBODY		Length of body, dimensional (real variable).

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
BCODE		Control index (integer) for specifying forebody shape. BCODE = 0 Parabolic = 1 Sears-Haack = 2 Tangent ogive = 3 Ellipsoidal = 4 Conical
<u>Item 10(a)</u>	(8F10.5)	Optional input read by subroutine VRTVEL when the effect of fixed external vortices are considered, for bodies with circular cross section only (RB = RA), $1 \le$ NVRTX ≤ 10.
GAMMA(I)	$\frac{\Gamma}{2\pi V_\infty a}$ (I)	Nondimensional vortex strengths, a is body radius RB, $1 \le I \le$ NVRTX.
YVRTX(I)	$\frac{y(I)}{a}$	Nondimensional y-coordinate, $1 \le I \le$ NVRTX.
ZVRTX(I)	$\frac{z(I)}{a}$	Nondimensional z-coordinate, $1 \le I \le$ NVRTX.
		There will be NVRTX sets of vortex inputs.
<u>Item 10(b)</u>	(3F10.5)	Optional input when the effect of fixed external vortices are considered, for bodies with elliptical cross section only (RB $\neq$ RA), $1 \le$ NVRTX ≤ 10.
GAMMA(I)	$\frac{\Gamma}{V_\infty}$ (I)	Vortex strength divided by free stream velocity, $1 \le I \le$ NVRTX.
YVRTX(I)	$y_w(I)$	y-coordinate in wing coordinate system of I'th vortex, $1 \le I \le$ NVRTX.
ZVRTX(I)	$z_w(I)$	z-coordinate in wing coordinate system of I'th vortex, $1 \le I \le$ NVRTX.
		There will be NVRTX sets of vortex inputs.
<u>Item 11</u>	(8I10)	
MLEVR		Number of leading-edge vortex information stations for the right horizontal fin.
MLEVL		Number of leading-edge vortex information stations for the left horizontal fin.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
MLEVU		Number of leading-edge vortex information stations for the upper vertical fin.
MLEVD		Number of leading-edge vortex information stations for the lower vertical fin.
Item 12	(6F10.5)	Optional input concerning leading-edge vorticity when MLEVR+MLEVL+MLEVU +MLEVD = NEDGV $\neq$ 0.
XLE(IFV)	$x_{w,LE}$	Wing x-coordinate of station of fin leading edge.
CGLOC(IFV)	$\bar{y}_{LE}$, $\bar{z}_{LE}$	Center of gravity of the leading-edge vorticity distribution.
GAMLE(IFV)	$\frac{\Gamma_{LE}}{V_\infty}$	Strength of the vorticity distribution at XLE(IFV), 1 $\leq$ IFV $\leq$ NEDGV.
Item 13	(I10)	
NSEV		Number of fin side-edge vortex information stations. Same for all fins.
Item 14	(6F10.5)	Optional input concerning side-edge vorticity when 4(NSEV) = NSIDGE $\neq$ 0.
XSE(JSE)	$x_{w,SE}$	Wing x-coordinate of station on fin side edge.
CGSELC(JSE)	$\bar{y}_{SE}$, $\bar{z}_{SE}$	Center of gravity of the side-edge vorticity distribution.
GAMSE(JSE)	$\frac{\Gamma_{SE}}{V_\infty}$	Strength of vorticity distribution at XSE(JSE), 1 $\leq$ JSE $\leq$ NSIDGE.
Item 15	(20A4)	
ZZZZ		End of information.

Description of Output

This section gives a summarized description of the output generated by program DEMON2 for a typical case involving one set of lifting surfaces on a body. Sample outputs are shown in connection with the discussion of 2 sample cases in section 6. In the following, the important items of output are described. Note that if print control indices NOUT and NPR are not set equal to zero in namelist $INPUT, very large output will be generated. As such, this additional output serves to aid in debugging.

The first page identifies the run. The second and possibly the third show the namelist $INPUT. All length dimensions in the output are the same as in the input.

On the next page, the wing geometry and flow conditions are listed. The quantities ALFA and BETA correspond to angle of pitch, α, and side-slip, β, respectively, calculated by the program, using the pitch-bank convention described in section 4, from the angle of incidence ALFAC and angle of roll PHI specified in namelist $INPUT. Information concerning the geometrical layout of the planar source panels used to model thickness of the lifting surfaces is then shown. On the next page, the specified streamwise slopes are printed. No thickness is accounted for for cases including interdigitated lifting surfaces.

If the body is circular in cross section, the next page shows name-list $BODY which was read in by subroutine BDYGEN. It is followed by the program calculated cylindrical coordinates of the body definition points and streamwise body slopes. Together with this body geometry output, the origin of each line singularity (line sources/sinks and line doublets) are given under the heading TX. All axial coordinates are in the body coordinate system with origin at the nose, refer to figure 1. The strengths of the singularities are given by T(I) for the line sources or sinks and by TC(I) for the line doublets. On the next pages, the output shows the pressures calculated on the circumference of the body with circular cross section. This information is calculated at axial locations under the heading XB in the body coordinate system. Each circumference or ring is given a BODY RING number which is written on top of the pressure point coordinates, the velocity component involved, pressure coefficients, body slopes, and pressure ratios. The pressures are calculated by subroutine BDYPR on the basis of the linear and Bernoulli pressure-velocity relationships. The latter is given by equation (10) in this report. If the pressures are calculated on the forebody, body nose shed vorticity characteristics can appear in the output if the included angle of attack is in excess of about 5°. The vorticity is represented by 2 concentrated vortices located symmetrically with respect to the crossflow free-stream component vector (unrolled coordinates). The vortex coordinates are also given in the body coordinate system (rolled coordinates) nondimensionalized by the local body radius. The calculated pressures include effects of the body nose vortices, if present. At the end of the print out of the pressures acting on the body, the number of control points, JCPT, is written. This number must be noted for runs involving the afterbody and tail fins, refer to sections 6.1.3 and 6.1.4.

For bodies with elliptical cross section, the horizontal and vertical semiaxes are printed immediately following the print out of local surface slope of the thickness distribution. Pressures at points on the surface of a body with elliptical cross section are calculated by program WDYBDY described in Appendix K.

The next pages of output contain the velocity components induced by external vortices, if applicable. They are calculated by program VPATH2 for axisymmetric bodies or by program VPATHL for bodies with elliptic cross section. Both programs are described in Appendix L. These programs compute the paths of the vortices and then proceed to calculate the vortex induced velocity components at the control points given under the headings XCP, YCP and ZCP.

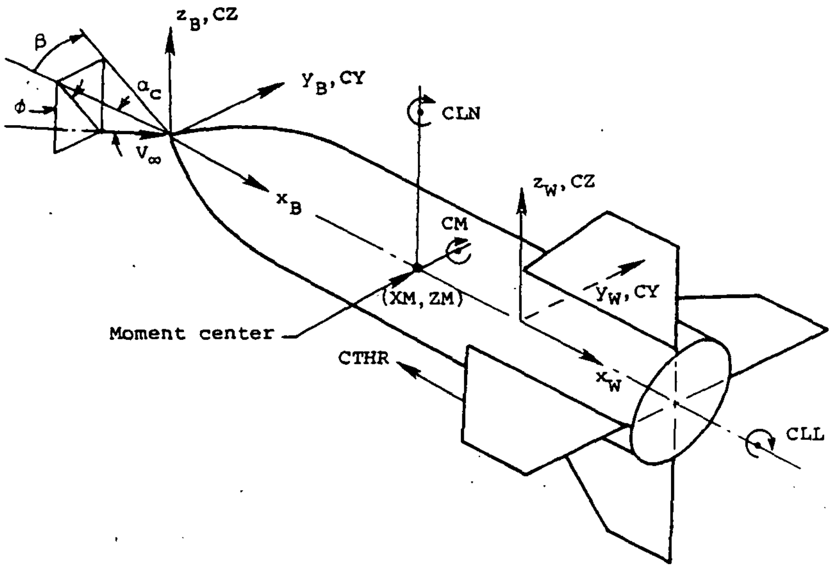
The next page in the output lists the calculated control point coordinates (x_W, y_W, z_W) in the wing coordinate system shown in figure 1 for the constant u-velocity panels distributed on the lifting surfaces. Perturbation velocities, in the wing coordinate system, induced at these points by the body and external vortices with their paths fixed to be parallel to the body centerline are also shown. The quantities BU, BV, BW and VVRTX, WVRTX, are due to body singularities and vortices specified in Item 10(a) or 10(b) of the input. The velocity components induced by the body singularities are calculated by subroutine VELCAL if the body is axisymmetric. For bodies with elliptic cross section, they are computed by program WDYBDY, stored on a data set and read in by subroutine BDYRD.

Coordinates of the control points associated with the body interference panels are given on the next page. They are expressed in the wing coordinate system. Velocity components THU(J), THV(J) and THW(J) are induced by the planar source panels on the lifting surfaces used to model thickness.

Loading information is printed on the next pages. First, the loadings are based on linear pressure loadings. For each lifting surface the force and moment coefficients, spanwise loading and suction distributions and distributions along the side edge of suction force are given. The heading specifies flow conditions and reference quantities including the moment-center coordinates in the body system. It is followed by a list of the deflection angle, thrust coefficient, CTHR, acting in the negative x_B (or x_W) direction, force coefficient CZ in the z_B (or z_W) direction, force coefficient CY in the y_B (or y_W) direction, pitching moment CM (nose up positive), yawing moment CLN (nose to right positive) and rolling-moment CLL (right wing down positive) coefficients.

Force coefficients CZ, CY and moment coefficients CM, CLN and CLL are also printed for the interference shell which covers the body over the length covered by the lifting surfaces. They are only representative of the lift carryover or interference from the lifting surfaces. If actual loads acting on this section of body are to be computed, the pressure distributions mentioned at the end of this section must be integrated.

So far, the loading coefficients have been expressed in the body axis system. For convenience, the positive directions of the forces and moments in the body coordinate system are indicated in the following sketch together with the body and wing reference coordinate systems. The loading information is also specified in the wind axis system, refer to section 4.2 in this report. All force and moment coefficients are then based on a coordinate system with its longitudinal axis aligned with the free stream vector. Under the heading SPANWISE DISTRIBUTIONS, the quantities of interest are the span loading CN*C/(2*B), thrust distribution CT*C/(2*B), suction distribution CS*C/(2*B) and the calculated leading-edge vorticity strength GAMMA,LE/VINF with its spanwise location YBAR. Quantity XLE is the axial coordinate, in the wing system, of the leading edge. The sums of the in-plane forces in coefficient form are then printed. Precise definitions of the terms SUMFX, SUMFY1, etc., are



given in Appendix C. Along the side edge, the distribution of suction force per unit length divided by the dynamic head times the tip chord is given together with the strength GAMMA,SE/VINF of the side-edge vorticity and the spanwise location YBAR. Quantity YBAR lies along the y_W coordinate. Finally, for the lifting surface at hand the strength(s) and spanwise location(s) of the concentrated trailing-edge vortex (vortices) are printed under the heading T.E. FIN INFO.

After displaying the loading information and spanwise distributions for all the lifting surfaces, the output of program DEMON2 proceeds to specify pressure distributions on the lifting surfaces calculated on the basis of the Bernoulli pressure expression, equation (10). PRESSA is the pressure coefficient acting on the upper side and PRESSB is the pressure coefficient on the lower side of the horizontal lifting surface. For a planar (monoplane) and cruciform fin or wing configuration, the horizontal surfaces lie in the z_W (or z_B) = 0 plane. For interdigitated fins, the horizontal fins are the right upper and left lower fins, refer also to figure 3 and the sketch in Appendix D. Coordinates X(J), Y(J) and Z(J) are in the wing coordinate system. The same pressure coefficient information is given for the vertical fins. For a cruciform fin configuration, the vertical surfaces lie in the y_W (or y_B) = 0 plane. For interdigitated fins, the vertical fins are the right lower and left upper fins, refer to figure 3 and the sketch in Appendix D. The loading pressures coefficients, DELTP,LIN. and DELTP,BERN., pertain to the differences in pressures acting on the lifting surfaces based on linear and Bernoulli pressure expressions, respectively.

The loading calculation is then repeated using the Bernoulli loading pressures. The next pages of output contain the same loading information described above but all results are now based on the Bernoulli pressure equation.

The calculation of loading information based on linear pressure loadings and Bernoulli pressure loadings serves the following purposes. It should be noted first that the linear loading pressures are directly related to the constant u-velocity panel strengths in accordance with equation (C2) in Appendix C whereas the Bernoulli pressures are computed from the velocity components, included angle of attack and roll angle as indicated by equations (9) and (10). Fin forces, moments and trailing edge vorticity characteristics (related to span load distributions as shown in Appendix B) should be taken from the loading information calculated with Bernoulli pressures. At low angles of attack with zero roll and in the absence of external vorticity, the loadings based on the two pressures will be comparable. However, any loading increment due to leading- and side-edge vorticity calculated with the Polhamus analogy must be taken from the loading information based on linear pressures. This is based on the fact that the characteristics of the leading- and side-edge vorticity are related to the suction distributions which is calculated using the constant u-velocity panel strengths as described in Appendix C.

Finally, the pressures acting at the control points of the body interference shell are printed out. They are a continuation of the pressures, described at the beginning of this section, calculated at points on the body ahead of the wing-body section at hand. The same remarks apply. The pressures include effects of body singularities, external vortices, planar source panels on the lifting surfaces, and all the constant u-velocity panels on the lifting surfaces and body interference shell.

Program Listing

The wing-body program DEMON2 is written in FORTRAN IV (029 punch) computer language for the CDC 6600 machine. The program consists of a main routine, CRFWBD and 32 subroutines. Their listings are shown on pages indicated below:

PROGRAM DEMON2

PROGRAM DEMON2

```
      PROGRAM CRFWBD(INPUT,OUTPUT,TAPE3,TAPE5=INPUT,TAPE6=OUTPUT,
     1 TAPE4,TAPE7)
C
C     VERSION:DEMON2.
C
C     PLANAR OR CRUCIFORM WING-BODY PROGRAM, SUPERSONIC FLOW
C     SET UP GEOMETRY, COORDINATES, AERODYNAMIC INFLUENCE COEFFICIENT
C     MATRIX, SOLVE FOR CONSTANT U-VELOCITY PANEL STRENGTHS.
C
      DIMENSION RHS(250),YR(20),YRT(20),THU(100),THV(100),THW(100),
     1YLT(20),HEAD(20),ZUT(20),ZDT(20)
C
      LOGICAL ASYM,BODY,DELTA,TRUSYM,NOSYM,DELTAS,TAIL,ASYMT
C
      COMMON FVN(1)
      COMMON/ONE/CIRC(250),DELTP(250),FN(250),PNLC(250),SWPPLE(250),
     1SWPPTE(250),VNOR(250),XBAR(250),ZBAR(250),XCPT(250),YCPT(250),ZCPT
     2(250),XLF(250),XLB(250),XRF(250),XRB(250),YLC(250),YRC(250),ZLF(25
     30),ZRF(250),ZLB(250),ZRB(250),SNT(125),CST(125),SNT2(125),CST2(125
     4),IP(300),XFBIP(100),A,ALFA,ALFR,ARWING,B2,B2V,BETA,BETAR,CONST,
     5COSALF,COSBET,CN,DX,EM,FMACH,RCIR,SINALF,SINBET,SLOPE,TLRNC,TIPY,
     6TOTLR,U,V,W,UCHK,VCHK,WCHK,WBIP,X,Y,Z,IV,IF,II,JV,MSWR,MSWL,MSWU,
     7MSWD,NBIP,NCRX,NCW,NDRAG,NHP,NPR,NRP,N3P,NOCPT,NOLINP,NOUT,NPANLS,
     8NPRESS,NWHP,ASYM,BODY,DELTAS,NOSYM
      COMMON/THREE/ANGLR,ANGLL,ANGLU,ANGLD,DELR,DELL,DELU,DELD,SREF,REFL
      COMMON/SWEEPS/VSWLER(20),VSWTER(20),VSWLEL(20),VSWTEL(20),
     1  VSWLEU(20),VSWTEU(20),VSWLED(20),VSWTED(20),LVSWP,LEFT,FAC,NCWB,
     2ARPNL(250),WIDTH(250)
      COMMON/BVEL/BOU(150),BOV(150),BOW(150),XFLOP(150),YFLOP(150),
     1 ZFLOP(150)
      COMMON/SPSANG/SINALC,COSALC,SINPHI,COSPHI
      COMMON/VRTXV/VVRTX(150),WVRTX(150),NVRTPL,NVRTX,VRTMAX
      COMMON/WHTR/THTI(125),XWLE
      COMMON/THKDAT/NTDAT,NCWT,NTPR,MSWT(4),NRPT,NHPT,N3PT,NTHP,ASYMT,
     1       NVERT,SWLET(20,4),SWTET(20,4),YTH(20,4),THETAL(400)
      COMMON/THVELO/TBETA,TTLRNC,THTSQ
      COMMON/ICVEL/UTCHK,VTCHK,WTCHK,IIT,IFT,MJ
      COMMON/TSPANS/SPANR,SPANL,SPANU,SPAND,SWPLER,SWPLEL,SWPLEU,
     1       SWPLED,SWPTER,SWPTEL,SWPTEU,SWPTED,RBOD
      COMMON/VPTHVL/VVEL(500),WVEL(500),JCPT,NCPOUT,NVLIN
      COMMON/VORSPC/GAMMA(10),YVRTX(10),ZVRTX(10),RLOC
      COMMON/FINLE/XLE(80),CGLOC(80),GAMLE(80),FKLE,NEDGV,MLEVR,MLEVL,
     1 MLEVU,MLEVD
      COMMON/FINSE/XSF(80),CGSELC(80),GAMSE(80),FKSE,NSIDGE,NSEV
      COMMON /ELLIPS/ RA,RB,ERATIO
      COMMON /INTRDT/ PHIDIH,THETIT,YBOD,ZBOD,PHIFR,PHIFU
      COMMON/OAFM/XM,ZM,CZOA,CYOA,CMOA,CLNOA,CLLOA
C
C
      DATA PI/3.14159265359/
      DATA QUIT/4HZZZZ/
C
      NAMELIST /INPUT/CRP,SWLEP,SWTEP,NCW,MSWR,MSWL,ALFAC,PHI,B2,FMACH,
     1  LVSWP,   FAC,        NFVNPR,        TOLFAC,MSWU,MSWD,SWLEV,SWTEV,
     1  CRPV,B2V,NCRX,RB,RA,ERATIO,NBDCR,DELR,DELL,DELU,DELD,SREF,REFL,
     1  PHIDIH,THETIT,XWLE,
     1 NOLINP,NOUT,NPR,NDRAG,NVRTX,NPRESS,VRTMAX ,NCWB,NAGAIN,BIL,
     1 ITAIL,NVRTPL, NBDYPR,NTPW,
     2NTDAT,NCWT,NCPOUT,NVLIN,XSTART,ICPT,FKLE,FKSE,XM,ZM
C
C
    1 FORMAT (20A4)
    2 FORMAT (1H1,20A4)
```

```
701 FORMAT(1H1,20X,15HWING GEOMETRY///
   3 16X,12HTIP CHORD = ,F10.5//
   4 17X,13HROOT CHORD = ,F10.5//
   9 14X,16HWING SEMISPAN = ,F10.5//)
702 FORMAT (//20X,15HFLOW CONDITIONS//5X,7HMACH = ,F10.5,4X,8HALPHAC=
   1 ,F10.5,4X,7HPHI  = ,F10.5,4X,7HALFA = ,F10.5,4X,7HBETA = ,F10.5/)
703 FORMAT(1H1,18X,52H                    PANEL CORNER COORDINATES FOR WING PA
   1NELS)
704 FORMAT (1H1,10X,30HCONTROL POINT COORDINATES FOR ,I2,14H CHORDWISE
   1 BY ,I2,32H SPANWISE PANELS ON WING 1 OR R,      ,2X,I2,5X,
   123HSPANWISE ON WING 2 OR L,    /53X,3HAND,I2,31H SPANWISE PANELS ON
   3WING 3 OR U,1X,I2,5X,    23HSPANWISE ON WING 4 OR D,      //
   4                          5X,1HJ,6X,4HX(J),8X,4HY(J),8X,4HZ(J),
   5  7X,5HBU(J),9X,5HBV(J),9X,5HBW(J),10X,5HVVRTX,10X,5HWVRTX,/)
705 FORMAT(1X,I5,2X,F10.5,2X,F10.5,2X,F10.5,2X,F12.5,2X,F12.5,
   1        2X,E12.5,2X,E12.5,2X,E12.5)
706 FORMAT(3X,I3,3X,F9.4,1X,F9.4,1X,F9.4,1H*,F9.4,1X,F9.4,1X,F9.4,
   1  1H*,F9.4,1X,F9.4,1X,F9.4,1H*,F9.4,1X,F9.4,1X,F9.4)
707 FORMAT(1H1,30X,20HINFLUENCE MATRIX FVN//)
708 FORMAT(/1X,58(1H=),13HWING 1 PANELS    ,59(1H=)/)
709 FORMAT(/1X,58(1H=),13HWING 2 PANELS    ,59(1H=)/)
710 FORMAT(/1X,58(1H=),13HWING 3 PANELS    ,59(1H=)/)
711 FORMAT(/1X,58(1H=),13HWING 4 PANELS    ,59(1H=)/)
712 FORMAT (8I10)
713 FORMAT(3F10.5)
714 FORMAT (6F10.5)
715 FORMAT(//  30X,15HPARAMETERS USED//
   1  12X,7HASYM = ,L3/12X,8HTLRNC = ,E12.5/12X,7HLEFT = ,L3/
   215X,7HBODY = ,L3,12X,8HDELTA = ,L3,11X,9HTRUSYM = ,L3,
   312X,8HNOSYM = ,L3///)
717 FORMAT(1H1,30X,21HSLOPES OF PANEL EDGES//6X,1HJ,5X,10HL.E. SLOPE,
   1  5X,10HT.E. SLOPE/)
716 FORMAT (15X,I2, 8X,F10.5, 17X, F10.5, 9X, F10.5)
718 FORMAT(5X,I3,5X,F10.5,5X,F10.5)
719 FORMAT( 9X,21HLEADING EDGE SWEEP = ,F10.5,2X,7HDEGREES//
   2 8X,22HTRAILING EDGE SWEEP = ,F10.5,2X,7HDEGREES/)
720 FORMAT(1H1, 5X,31HCONTROL POINTS WRITTEN ON TAPE4 //
   *    ,4X,1HI,4X,4HXCPT,8X,4HYCPT,8X,4HZCPT)
721 FORMAT(9X,8HCRPTV = ,F10.5//)
722 FORMAT (//10X,25HRIGHT WING PART SPAN = ,F10.5/
   110X,  25H LEFT WING PART SPAN = ,F10.5)
723 FORMAT(//10X,7HCRPT = ,F10.5)
724 FORMAT (1H1,10X,75H TWO DIMENSIONAL VORTEX STRENGTHS AND FIXED COO
   1RDINATES IN CROSS FLOW PLANE//
   215X,5HIVRTX, 6X,  10HGAMMA/VINF, 19X,
   3 5HYVRTX,14X,5HZVRTX//)
725 FORMAT(1H1,30X,48HCONTROL POINT COORDINATES FOR BIP*S (WING FRAME)
   1        //5X,1HJ,6X,4HX(J),8X,4HY(J),8X,4HZ(J),6X,6HTHU(J),8X,
   2        6HTHV(J),8X,6HTHW(J)//)
726 FORMAT(///25X,36HBIP CORNER COORDINATES IN WING FRAME)
727 FORMAT(10X,25HUPPER WING PART SPAN = ,F10.5/
   1        10X,25HLOWER WING PART SPAN = ,F10.5//)
728 FORMAT(1H1,30X,22HRIGHT HAND SIDE VECTOR//4X,1HJ,5X,6HRHS(J)//)
729 FORMAT(2X,I3,2X,E12.5)
731 FORMAT(1H1,30X,19HPRESSURE ON PANEL J//4X,1HJ,4X,4HP(J)//)
7030 FORMAT (                                   //5X,1HJ,15X,2HLF,15X,
   1  1H*,12X,2HLR,15X,1H*,12X,2HRF,15X,1H*,12X,2HRR/12X,1HX,9X,1HY,
   2  9X,1HZ,5X,1H*,3X,1HX,9X,1HY,9X,1HZ,5X,1H*,3X, 1HX,9X,1HY,9X,1HZ,
   3  5X,1H*,3X,1HX,9X,1HY,9X,1HZ/38X,1H*,29X,1H*,29X,1H*/130(1H*)/
   4  38X,1H*,29X,1H*,29X,1H*)
732 FORMAT (3X,69HSPECIFIED SPANWISE LOCATIONS OF OUTBOARD PANEL EDGES
   1 AND SWEEP ANGLES//2X,1HK,4X,6HY OR Z,7X,10HL.E. SWEEP,5X,
   2 10HT.E. SWEEP/23X,5HANGLE,10X,5HANGLE///)
```

```
  733 FORMAT (1X,I2,2X,F10.5,2(5X,F10.5))
  734 FORMAT (1H1,4X,14HWING 1 SURFACE //)
  735 FORMAT (1H1,4X,14HWING 2 SURFACE //)
  736 FORMAT (1H1,4X,14HWING 3 SURFACE //)
  737 FORMAT (1H1,4X,14HWING 4 SURFACE //)
  744 FORMAT (1H1,4X,12HWING SURFACE//)
  745 FORMAT (I5,3G12.5)
  746 FORMAT (I5,5E12.5)
  747 FORMAT (1H1,10X,83HPOINT COORDINATES AND PERTURBATION VELOCITIES C
     1ALCULATED BY PROGRAM VPATH OR VPATHL,//,
     2 5X,2HIC,5X,3HXCP,9X,3HYCP,9X,3HZCP,8X,8HVVEL(IC),6X,8HWVEL(IC)/)
C
C
C
  999 CONTINUE
C
C     DEFAULT VALUES FOR NAMELIST INPUT
C
      ASYM=.FALSE.
      BIL=0.0
      BODY=.FALSE.
      B2V=0.0
      CRPV=0.0
      DELR=0.0
      DELL=0.0
      DELU=0.0
      DELD=0.0
      FRATIO=1.
      FAC=0.95
      FKLE=0.5
      FKSE=0.5
      ITAIL=0
      JCPT=0
      LVSWP=0
      MSWL=0
      MSWD=0
      MSWU=0
      NAGAIN=0
      NBDCR=0
      NBDYPR=0
      NCPOUT=0
      NCRX=0
      NCWB=0
      NCWT=0
      NDRAG=0
      NFVNPR=0
      NOLINP=0
      NOUT=0
      NPR=0
      NPRESS=0
      NTDAT=0
      NTPR=0
      NVLIN=0
      NVRTPL=0
      NVRTX=0
      PHI=0.0
      RA=0.
      RB=0.0
      REFL=1.0
      SREF=1.0
      SWLEP=0.0
      SWLEV=0.0
      SWTEP=0.0
```

```
      SMTEV=0.0
      TOLFAC=1.0
      VRTMAX=0.35
      XM=0.0
      XSTART=0.0
      XMLE=0.0
      ZM=0.0
C
C        THE FOLLOWING FIN ORIENTATION ANGLES AND TRIG. FUNCTIONS ARE
C     THE DEFAULT VALUES FOR  CRUCIFORM FIN CASE.
C
      PHIFR=0.0
      PHIFL=0.0
      PHIFU=90.0
      PHIFD=90.0
      THETR=0.0
      THETL=0.0
      THETU=90.0
      THETD=90.0
      PHIDIH=0.0
      THETIT=0.0
C
C
C
C***********************************************************************
C     SET CORE REQUIREMENT BASED ON EVN(1)                             *
      LFL=0
      CALL REQFL(LFL)
C                                                                      *
C***********************************************************************
C
C     WING GEOMETRY SPECIFIED IN PLANFORM,
C     GEOMETRICALLY SYMMETRIC WINGS ONLY
C
C
C     READ HEADER CARD
C
      READ(5,1) HEAD
      IF(HEAD(1).EQ.QUIT) STOP
C
C     READ NAMELIST INPUT
C
      READ (5,INPUT)
C
C
C     ANGLE OF ATTACK AND SIDESLIP ARE CALCULATED IN ACCORDANCE WITH
C     PITCH-ROLL TRANSFORMATION, SEE NIELSEN PAGE 5.
C
      DTOR=PI/180.0
      ALFACR=ALFAC*DTOR
      SINALC=SIN(ALFACR)
      COSALC=COS(ALFACR)
      PHIR=PHI*DTOR
      SINPHI=SIN(PHIR)
      COSPHI=COS(PHIR)
      SINALF=SINALC*COSPHI
      ALFR=ASIN(SINALF)
      COSALF=COS(ALFR)
      SINBET=SINALC*SINPHI
      BETAR=ASIN(SINBET)
      COSBET=COS(BETAR)
      BETAY=BETAR/DTOR
      ALFA=ALFR/DTOR
```

```
C
C     FIN ANGLE PROPERTIES
C
      SLPWLE=TAN(SWLEP*DTOR)
      SLPWTE=TAN(SWTEP*DTOR)
      SLPVLE=TAN(SWLEV*DTOR)
      SLPVTE=TAN(SWTEV*DTOR)
C
C        CHECK FOR INTERDIGITTATED TAIL DIHEDRAL ANGLES
C
C NOTE: IF INTERDIGITATED FINS ARE UNDER CONSIDERATION,THE FOLLOWING
C     CORRELATION HOLDS.
C
C        RIGHT UPPER FIN.....RIGHT OR 1
C        LEFT LOWER FIN.....LEFT OR 2
C        RIGHT LOWER FIN.....UPPER OR 3
C        LEFT UPPER FIN.....LOWER OR DOWN OR 4
C     THIS DESIGNATION ESTABLISHES CORRESPONDENCE BETWEEN CRUCIFORM AND
C     INTERDIGITATED FINS.
C NOTE:THE DIHEDRAL ANGLE DEFINED AS THE CANT ANGLE HERE.
C
      IF (THETIT.LE.0.0 .OR. THETIT.GE.90.) GO TO 22
C
C        PHIFR = UPPER RIGHT CANT ANGLE.   PHIFL = LOWER LEFT CANT ANGLE
C        PHIFU = LOWER RIGHT CANT ANGLE,   PHIFD = UPPER LEFT CANT ANGLE
C
      PHIFR= PHIDIH
      PHIFL= PHIDIH
      PHIFU=-PHIDIH
      PHIFD=-PHIDIH
C
C
C     THETR,THETU DEFINE LOCATIONS OF RHS FINS ON BODY CIRCUMFERENCE
C                 MEASURED POS. FROM +Y-AXIS COUNTERCLOCKWISE.
C     THETL,THETD DEFINE LOCATIONS OF LHS FINS ON BODY CIRCUMFERENCE
C                 MEASURED POS. FROM -Y-AXIS COUNTERCLOCKWISE.
C
      THETR= THETIT
      THETL= THETIT
      THETU=-THETIT
      THETD=-THETIT
   22 CONTINUE
C
C     ELLIPSE PROPERTIES
C        RB...HORIZONTAL SEMI-AXIS
C        RA...VERTICAL SEMI-AXIS
C
      IF (RA.EQ.0. .AND .RB.EQ.0.) GO TO 23
      IF (RA.EQ.0.) RA=RB/ERATIO
      IF (RB.EQ.0.) RB=RA*ERATIO
      ERATIO=RB/RA
   23 CONTINUE
      RCIR=SQRT(RA*RB)
      RHOD=RB
C
C
C     LOGICAL VARIABLE ASYM GOVERNS LAYOUT OF SKEWED PANELS WHICH
C     ONLY CAN BE DONE WHEN THERE IS NO BODY PRESENT.
C     PRESENTLY,PLANAR DELTA WINGS ONLY.
C
C     LOGICAL VARIABLE TRUSYM MAKES USE OF GEOMETRIC AND LOADING
C     SYMMETRY PROPERTIES
C
```

```
      ASYM=(BETAY.NE.0.0).AND.(NBDCR.EQ.0)
      BODY=NBDCR.NE.0
      DELTA=DELR.NE.0..OR.DELL.NE.0..OR.DELU.NE.0..OR.DELD.NE.0.
      DELTAS=DELR.NE.DELL.OR.DELU.NE.0..OR.DELD.NE.0.
      TRUSYM=BETAY.EQ.0.0.AND..NOT.DELTAS
      NOSYM= .NOT. TRUSYM
      TAIL=ITAIL .NE. 0
C
      TIPY=B2
      NRP=NCW*MSWR
      NRP1=NRP+1
      NHP=NCW*(MSWR+MSWL)
      NHP1=NHP+1
      N3P=NCW*(MSWL+MSWR+MSWU)
      N3P1=N3P+1
      NPANLS=NCW*(MSWR+MSWL+MSWU+MSWD)
      IF (TRUSYM) NPANLS=NRP
      IF (TRUSYM .AND. THETIT.GT.0.) NPANLS=NCW*(MSWR+MSWU)
      NPANLP=NPANLS+1
      NBIP=NCNB*NBDCR
      IF (TRUSYM.AND.BODY) NBIP=NBIP/2
      NWBP=NPANLS+NBIP
      IF (NWBP.GT.8) NPR=0
C
      WRITE (6,2) HEAD
C
C
C     ANGLES ANGLR,ANGLL,ANGLU,ANGLD GOOD ONLY FOR CRUCIFORM FINS OR
C     MONO-PLANE WING.
C
      RDELR=DELR*DTOR
      ANGLR=RDELR + ALFR
      RDELL=DELL*DTOR
      ANGLL=ALFR+RDELL
      RDELU=DELU*DTOR
      ANGLU=BETAR+RDELU
      RDELD=DELD*DTOR
      ANGLD=BETAR+RDELD
      BETA=SQRT(ABS(FMACH*FMACH-1.) )
      TLRNC=(B2*15.E-5)**2*TOLFAC
      TOTLR=2.0*TLRNC
      CONST= 4.0*PI
      TBETA=BETA
      TBTSQ=BETA*BETA
      TTLRNC=TLRNC
      NVERT=NCRX
      ASYMT=ASYM
C
C
      WRITE(6,INPUT)
      IF (NAGAIN.GT.1) GO TO 53
C
C
C***********************************************************************
C     UP TO STATEMENT 69 IS FOR WING ALONE CASE
C***********************************************************************
C     NOTE: IF NDRAG=1, USE A MAXIMUM OF 150 PANELS
C
      IF(ASYM.OR.BODY.OR.NCRX.NE.0) GO TO 69
      MSWRP=MSWR+1
      IF(LVSWP.EQ.0) GO TO 25
C
C     FOR THIS CASE YR(KJ) MEASURED FROM WING CENTERLINE.
```

```
C
      READ(5,713) (YR(KJ),VSWLER(KJ),VSWTER(KJ),KJ=1,MSWRP)
      SWPLER=VSWLER(MSWRP)
      SWPTER=VSWTER(MSWRP)
      GO TO 26
C
C     LAY OUT THE SPANWISE LOCATION OF PANEL RHS, YR(I)IN THE PLANFORM
C     PLANE
C     IF THEY WERE NOT READ IN ALREADY
C
   25 YR(1)=0.0
      YR(MSWRP)=B2
      DY=B2/MSWR
      DO 110 I=2,MSWR
      AI=I-1
  110 YR(I)= YR(1)+DY*AI
      SWPLER=SWLEP
      SWPTER=SWTEP
   26 SPANR=B2
      CRPT=CRP
      GO TO 68
C
C     IF WITH SIDESLIP AND WITHOUT BODY.
C     YAWED WING GEOMETRY LAID OUT RELATIVE TO LINE FORMED BY
C     INTERSECTION OF STREAMWISE PLANE THROUGH WING ROOT CHORD LE AND
C     WING PLANFORM PLANE (A STREAMWISE LINE)
C     THIS PROGRAM OPTION CAN ONLY BE USED FOR DELTA WING
C     WITHOUT BODY.
C
   69 CONTINUE
      MSWRP=MSWR+1
      MSWLP=MSWL+1
      MSWUP=MSWU+1
      MSWDP=MSWD+1
      IF (BODY) GO TO 74
      IF (.NOT.ASYM) GO TO 74
      IF (LVSWP.NE.0) GO TO 60
      SWPLER=SWLEP-BETAY
      SWPTER=SWTEP-BETAY
      SWPLEL=SWLEP+BETAY
      SWPTEL=SWTEP+BETAY
      CTP=CRP-B2*(SLPWLE-SLPWTE)
      CRPT= CRP*(COSBET+SINBET*TAN(SWPTEL*DTOR))
      SPANL= (B2/COS(SWLEP*DTOR))*COS(SWPLEL*DTOR)
      SPANR=(B2/COS(SWLEP*DTOR))*COS(SWPLER*DTOR)+CTP*SINBET
      GO TO 76
C
C     SET UP GEOMETRICALLY SYMMETRIC LAY-OUT.
C
   74 SWPLER=SWLEP
      SWPTER=SWTEP
      SWPLEL=SWLEP
      SWPTEL=SWTEP
      CRPT=CRP
      SPANR=B2
      SPANL=B2
   76 CONTINUE
      IF(NCPY.EQ.0) GO TO 77
C
C     CASE FOR VERTICAL WING PANELS
C
      IF (BODY) GO TO 75
```

```
      IF (.NOT.ASYM) GO TO 75
      SWPLEU=SWLEV+ALFA
      SWPTEU=SWTEV+ALFA
      SWPLED=SWLEV-ALFA
      SWPTED=SWTEV-ALFA
      CTPV=CRPV-B2V*(SLPVLE-SLPVTE)
      CRPTV=CRPV*(COSALF+SINALF*TAN(SWPTEU*DTOR))
      SPANU=(B2V/COS(SWLEV*DTOR))*COS(SWPLEU*DTOR)
      SPAND=(B2V/COS(SWLEV*DTOR))*COS(SWPLED*DTOR)+CTPV*SINALF
      GO TO 77
   75 SWPLEU=SWLEV
      SWPTEU=SWTEV
      SWPLED=SWLEV
      SWPTED=SWTEV
      CRPTV=CRPV
      SPANU=B2V
      SPAND=B2V
   77 CONTINUE
C
C
      SLPWLR= TAN(SWPLER*DTOR)
      SLPWTR= TAN(SWPTER*DTOR)
      SLPWLL= TAN(SWPLEL*DTOR)
      SLPWTL= TAN(SWPTEL*DTOR)
      IF (NCRX.EQ.0) GO TO 64
      SLPWLU=TAN(SWPLEU*DTOR)
      SLPWLD=TAN(SWPLED*DTOR)
      SLPWTU=TAN(SWPTEU*DTOR)
      SLPWTD=TAN(SWPTED*DTOR)
   64 IF (LVSWP.EQ.0) GO TO 65
C
C     READ IN NON UNIFORM DISTANCES TO PANEL OUTBOARD EDGES.
C     IF WITH A BODY, MEASURE FROM FIN ROOT CHORD.
C
   60 READ (5,713) (YRT(KJ),VSWLER(KJ),VSWTER(KJ),KJ=1,MSWRP)
      SWPLER=VSWLER(MSWRP)
      SWPTER=VSWTER(MSWRP)
      SWPLEU=SWPLER
      SWPTEU=SWPTER
      SPANR=YRT(MSWRP)-YRT(1)
      SPANL=SPANR
      SPANU=SPANR
      IF (TRUSYM.AND. THETIT.LE.0.) GO TO 68
      IF (TRUSYM) GO TO 61
      READ (5,713) (YLT(KJ),VSWLEL(KJ),VSWTEL(KJ),KJ=1,MSWLP)
      SWPLEL=-VSWLEL(MSWLP)
      SWPTEL=-VSWTEL(MSWLP)
      SPANL=-(YLT(MSWLP)-YLT(1))
      IF (NCRX.EQ.0) GO TO 68
C
C     IF TRUSYM IS TRUE AND INTERDIGITATED TAIL IS TREATED,
C     DATA IS EXPECTED FOR THE RIGHT UPPER AND LOWER FINS
C
   61 READ(5,713) (ZUT(KJ),VSWLEU(KJ),VSWTEU(KJ),KJ=1,MSWUP)
      SWPLEU=VSWLEU(MSWUP)
      SWPTEU=VSWTEU(MSWUP)
      SPANU=ZUT(MSWUP)-ZUT(1)
      IF (TRUSYM) GO TO 68
      READ(5,713)  (ZDT(KJ),VSWLED(KJ),VSWTED(KJ),KJ=1,MSWDP)
      SWPLED=-VSWLED(MSWDP)
      SWPTED=-VSWTED(MSWDP)
      SPAND=-(ZDT(MSWDP)-ZDT(1))
      GO TO 68
   65 CONTINUE
```

```
C
C     EQUAL SPANWISE WIDTHS, CONSTANT SWEEPS
C     PANELS IN HORIZONTAL WING SURFACES
C
      YRT(1)=0.0
      YRT(MSWRP)=SPANR+YRT(1)
      DYR=SPANR/MSWR
      DO 51 I=2,MSWR
      AI=I-1
   51 YRT(I)=DYR*AI+YRT(1)
      IF (TRUSYM .AND. THETIT.EQ.0.0) GO TO 68
C
      IF (TRUSYM) GO TO 57
      YLT(1)=0.0
      YLT(MSWLP)=-SPANL+YLT(1)
      DYL=SPANL/MSWL
      DO 52 I=2,MSWL
      AI=I-1
   52 YLT(I)=-DYL*AI+YLT(1)
      IF (NCRX.EQ.0) GO TO 68
C
C     PANELS IN VERTICAL PLANE
C
   57 ZUT(1)=0.0
      ZUT(MSWUP)=SPANU+ZUT(1)
      DZU=SPANU/MSWU
      DO 54 I=2,MSWU
      AI=I-1
   54 ZUT(I)=DZU*AI+ZUT(1)
C
      IF (TRUSYM) GO TO 68
      ZDT(1)=0.0
      ZDT(MSWDP)=-SPAND+ZDT(1)
      DZD=SPAND/MSWD
      DO 55 I=2,MSWD
      AI=I-1
   55 ZDT(I)=-DZD*AI+ZDT(1)
   68 CONTINUE
C
      IF (LVSWP.EQ.0) GO TO 79
      IF (ASYM.OR.BODY.OR.NCRX.NE.0) GO TO 28
      WRITE (6,744)
      WRITE (6,732)
      DO 29 K=1,MSWRP
   29 WRITE (6,733) K,YR(K),VSWLER(K),VSWTER(K)
      GO TO 79
   28 WRITE (6,734)
      WRITE (6,732)
      DO 80 K=1,MSWRP
   80 WRITE (6,733) K,YRT(K),VSWLER(K),VSWTER(K)
      IF (TRUSYM .AND. THETIT.LE.0.) GO TO 79
      IF (TRUSYM) GO TO 84
      WRITE (6,735)
      DO 81 K=1,MSWLP
   81 WRITE (6,733) K,YLT(K),VSWLEL(K),VSWTEL(K)
      IF (NCRX.EQ.0) GO TO 79
   84 WRITE (6,736)
      DO 82 K=1,MSWUP
   82 WRITE (6,733) K,ZUT(K),VSWLEU(K),VSWTEU(K)
      IF (TRUSYM) GO TO 79
      WRITE (6,737)
      DO 83 K=1,MSWDP
   83 WRITE(6,733) K,ZDT(K),VSWLED(K),VSWTED(K)
```

```
   79 CONTINUE
C
C
C     LAY-OUT ELEMENTAL PANELS ON WING ALONE.
C
      IF(ASYM.OR.BODY.OR.NCRX.NE.0) GO TO 50
      CALL LAYOUT(SLPWLE,SLPWTE,YR,NSWRP,CRP,1,CTP,PHIFR,THETR)
      IF (NOUT.EQ.1) WRITE (6,715) ASYM,TLRNC,LEFT,BODY,DELTA,TRUSYM,
      NOSYM
      GO TO 53
C
C
C     LAY-OUT ELEMENTAL PANELS ON THE FINS.
C
C    NOTE: DISTANCES YRT,YLT,ZUT,ZDT ARE MEASURED FROM THE FIN ROOT
C     CHORDS IF BODY IS PRESENT
C
C
   50 CALL LAYOUT(SLPWLR,SLPWTR,YRT,NSWRP,CRPT,1,CTP,PHIFR,THETR)
      IF (NOUT.EQ.1) WRITE (6,715) ASYM,TLRNC,LEFT,BODY,DELTA,TRUSYM,
     1NOSYM
      IF (NCRX.NE.0) CTPV=CTP
      IF (TRUSYM .AND. THETIT.LE.0.0) GO TO 62
C
      IF (TRUSYM) GO TO 63
      CALL LAYOUT(SLPWLL,SLPWTL,YLT,NSWLP,CRPT,2,CTPL,PHIFL,THETL)
      IF (NOUT.EQ.1) WRITE (6,715) ASYM,TLRNC,LEFT,BODY,DELTA,TRUSYM,
     1NOSYM
      IF (NCRX.EQ.0) GO TO 62
C
   63 CALL LAYOUT(SLPWLU,SLPWTU,ZUT,NSWUP,CRPTV,3,CTPV,PHIFU,THETU)
      IF (NOUT.EQ.1) WRITE (6,715) ASYM,TLRNC,LEFT,BODY,DELTA,TRUSYM,
     1NOSYM
C
      IF (TRUSYM) GO TO 62
      CALL LAYOUT(SLPWLD,SLPWTD,ZDT,NSWUP,CRPTV,4,CTPVD,PHIFD,THETD)
      IF (NOUT.EQ.1) WRITE (6,715) ASYM,TLRNC,LEFT,BODY,DELTA,TRUSYM,
     1NOSYM
C
C     LAY-OUT BODY INTERFERENCE PANELS
C
   62 IF(NBDCR.EQ.0) GO TO 53
      CALL LAYOUT(SLPWLE,SLPWTE,0.0,NBDCR,HIL,5,0.,0.,0.)
      IF (NOUT.EQ.1) WRITE (6,715) ASYM,TLRNC,LEFT,BODY,DELTA,TRUSYM,
     1NOSYM
   53 CONTINUE
C
C
      WRITE(6,701)  CTP,CRP,B2
      IF (LVSWP.EQ.0) WRITE(6,719) SWLEP,SWTEP
      WRITE (6,702) FMACH,ALFAC,PHI,ALFA,BETAY
      IF(.NOT.ASYM) GO TO 56
      WRITE(6,722) SPANR,SPANL
      IF(NCRX.NE.0)WRITE(6,727) SPANU,SPAND
   56 CONTINUE
      WRITE(6,723) CRPT
      IF(NCRX.NE.0) WRITE(6,721) CRPTV
      IF (NOUT.NE.1) GO TO 7813
      WRITE(6,703)
      WRITE(6,7030)
      WRITE(6,708)
      WRITE(6,706) (J,XLF(J),YLC(J),ZLF(J),XLR(J),YLC(J),ZLR(J),XRF(J),
     1  YRC(J),ZRF(J),XRR(J),YRC(J),ZRR(J),J=1,NRP)
```

```
      IF (TRUSYM .AND. THETIT.LE.0.) GO TO 71
C
      IF (TRUSYM) GO TO 73
      WRITE(6,709)
      WRITE(6,706) (J,XLF(J),YLC(J),ZLF(J),XLB(J),YLC(J),ZLB(J),XRF(J),
     1  YRC(J),ZRF(J),XRB(J),YRC(J),ZRB(J),J=NRP1,NHP)
      IF(NCRX.EQ.0) GO TO 71
C
   73 WRITE(6,710)
      WRITE(6,706) (J,XLF(J),YLC(J),ZLF(J),XLB(J),YLC(J),ZLB(J),XRF(J),
     1  YRC(J),ZRF(J),XRB(J),YRC(J),ZRB(J),J=NHP1,NSP)
      IF (TRUSYM) GO TO 71
C
      WRITE(6,711)
      WRITE(6,706) (J,XLF(J),YLC(J),ZLF(J),XLB(J),YLC(J),ZLB(J),XRF(J),
     1  YRC(J),ZRF(J),XRB(J),YRC(J),ZRB(J),J=N3P1,NPANLS)
C
   71 IF(NBDCR.EQ.0) GO TO 72
      WRITE(6,726)
      WRITE(6,7030)
      WRITE (6,706) (J,XLF(J),YLC(J),ZLF(J),XLB(J),YLC(J),ZLB(J),XRF(J),
     1YRC(J),ZRF(J),XRB(J),YRC(J),ZRB(J),J=NPANLP,NWBP)
      WRITE (6,717)
      WRITE (6,718) (J,SWPPLE(J),SWPPTE(J),J=1,NWBP)
      GO TO 7813
   72 WRITE(6,717)
      WRITE(6,718) (J,SWPPLE(J),SWPPTE(J),J=1,NPANLS)
 7813 CONTINUE
C
C
C
C     INPUT THICKNESS DATA, PRINT INPUT VALUES, AND LAY
C     OUT SOURCE PANELS ON FINS.
C     SUBROUTINE THKIN READS IN STREAMWISE THICKNESS SLOPES.
C
      IF(NTDAT.EQ.0) GO TO 88
      CALL THKIN
      CALL THKOUT
      CALL THKLYT(CRPT,0)
      IF(ASYM) CALL THKLYT(CRPT,1)
C
      IF(NCRX.EQ.0) GO TO 88
      CALL THKLYT(CRPTV,2)
      IF(ASYM) CALL THKLYT(CRPTV,3)
   88 CONTINUE
C
C     INITIALIZE BODY INDUCED VELOCITIES AND VORTEX INDUCED VELOCITIES
C
      DO 10 KM=1,150
      VVRTX(KM)=0.0
      WVRTX(KM)=0.0
      BDU(KM)=0.0
      BDV(KM)=0.0
   10 BDW(KM)=0.0
C
      DO 11 IC=1,500
      VVEL(IC)=0.0
   11 WVEL(IC)=0.0
C
C
C     WHEN NCPOUT NOT ZERO,
C     PUT WING OR FIN CONTROL POINTS AND BODY INTERFERENCE PANEL
C     CONTROL POINTS IN DATA SET ON TAPE 4.
```

Page Intentionally Left Blank

Page Intentionally Left Blank

```
C
C     SPECIAL PURPOSE CORE MEMORY ECONOMY SECTION FOR BCS 6600
C     SET CORE REQUIREMENT BASED ON LFL PLUS FVN(NWBP,NWBP)
C     NOTE: ALREADY SET FVN(1).
C
      MFLTOT=LFL+NWBP*NWBP-1
      CALL REQFL(MFLTOT)
C
C***********************************************************************
C
C     SET UP INFLUENCE COEFFICIENT MATRIX
C     IT IS THE LHS OF THE FLOW TANGENCY CONDITION.
C     NOTE: THE B.C. STATES THAT VELOCITY NORMAL TO THE PANELS MUST
C     BE ZERO.
C     THEREFORE ALL VELOCITIES MUST BE TRANSFORMED INTO INDIVIDUAL
C     FLAP COORDINATE SYSTEM.
C
C
C     CALCULATE THE INFLUENCE OF EACH PANEL ON EACH CONTROL POINT
C     II AND IF ARE THE LIMITS FOR SUMMATION OF THE INFLUENCE FUNCTION
C     IN SUBROUTINE VELNOR
C     IF II = IF, THE INFLUENCE OF A SINGLE PANEL AT A POINT RESULTS
C     AS IN THE COMPUTATION OF THE ARRAY FVN.  IF II=1 AND IF=NWBP,
C     THE INFLUENCES ARE SUMMED OVER ALL PANELS, AS IN THE COMPUTATION O
C     RESULTANT VELOCITIES BELOW....
C
C     --- I IS THE INDEX OF THE INFLUENCING PANEL
C
C
      JJ=0
      NOCPT=0
      DO 450 I=1,NWBP
      II=I
      IF=I
C
C     J IS THE INDEX OF THE INFLUENCED PANEL,I.E. ITS CONTROL POINT.
C
      DO 425 J=1,NWBP
      JB=J-NPANLS
      CALL VELNOR(XCPT(J),YCPT(J),ZCPT(J))
      JJ=JJ+1
      IF(J.LE.NPANLS) GO TO 417
C
C     INFLUENCED PANEL IS ON THE BODY INTERFERENCE SHELL.
C
      CALL ROTWB (VCHK,WCHK,VV,WW,JB)
      GO TO 418
C
C     INFLUENCED PANEL IS ON A FIN.
C
  417 IF (J.LE.NHP) PHIF=PHIFR*DTOR
      IF (J.GT.NHP.AND.J.LE.NPANLS) PHIF=PHIFU*DTOR
      CALL ROTWF(VCHK,WCHK,VV,WW,PHIF)
  418 FVN(JJ)=WW
  425 CONTINUE
  450 CONTINUE
C
C     DEBUG DUMP OF THE FVN ARRAY
C
      IF(NFVNPR.EQ.0) GO TO 618
      WRITE (6,707)
      CALL OUT(FVN,NWBP)
  618 CONTINUE
```

```
      CALL LINEQS(NWBP,FVN)
      IF (NAGAIN.NE.1) GO TO 9000
      JMAX=NWBP**2
      REWIND 3
      BUFFER OUT (3,1) (FVN(1),FVN(JMAX))
      NAGAIN=NAGAIN+1
      IF (UNIT(3)) 27,27,27
   27 CONTINUE
      GO TO 9000
C***********************************************************************
C
C     CASE FOR NAGAIN G.T. 1, SET REQUIRED FIELD LENGTH.
C
 8889 JMAX=NWBP**2
      MFLTOT=LFL+NWBP*NWBP-1
      CALL REQFL(MFLTOT)
C
C***********************************************************************
      REWIND 3
      BUFFER IN (3,1) (FVN(1),FVN(JMAX))
      IF (UNIT(3)) 30,30,30
   30 CONTINUE
 9000 CONTINUE
C
C     SET UP SINGLE COLUMN MATRIX RHS FOR RIGHT HAND SIDE
C     IT REPRESENTS THE EXTERNALLY INDUCED VELOCITIES AND ANGLE OF
C     PITCH AND SIDESLIP EFFECTS AS WELL AS FIN THICKNESS.
C  NOTE: NO THICKNESS EFFECTS ACCOUNTED FOR IF INTERDIGITATED FINS
C     ARE CONSIDERED.
C
C
      IF (NVLIN.EQ.0.OR.ITAIL.EQ.1) GO TO 607
      REWIND 7
      WRITE (6,747)
  607 CONTINUE
C
C     CASE FOR WING OR FIN ALL AT SAME ANGLE AS BODY
C
C     READ IN VELOCITIES INDUCED BY MOVING VORTICES (CALCULATED BY
C     PROGRAM VPATH) AT ALL CONSTANT U-VELOCITY PANEL CONTROL POINTS.
C
C
      IF(DELTA) GO TO 627
      DO 620 I=1,NWBP
      IC=I
      IF (NVLIN.EQ.0.OR .ITAIL.EQ.1) GO TO 605
      READ (7,746) IC,XCP,YCP,ZCP,VVEL(IC),WVEL(IC)
      WRITE (6,705) IC,XCP,YCP,ZCP,VVEL(IC),WVEL(IC)
  605 CONTINUE
      WEXT=SINALF+BDW(I)+WVRTX(I)+WVEL(IC)
      VEXT=-SINBET+BDV(I)+VVRTX(I)+VVEL(IC)
      IF (I.GT.NPANLS) GO TO 601
      IF(I.LE.NHP) GO TO 602
      IF(I.LE.NPANLS) GO TO 604
  601 RHS(I)=0.0
      GO TO 620
  602 PHIF=PHIFR*DTOR
      CALL ROTWF(VEXT,WEXT,VV,WW,PHIF)
      RHS(I)=-WW
      GO TO 620
  604 PHIF=PHIFU*DTOR
      CALL ROTWF(VEXT,WEXT,VV,WW,PHIF)
```

```
      RHS(I)=-WW
  620 CONTINUE
      GO TO 646
C
C     RIGHT HAND SIDE FOR WINGS OR FINS TILTED WITH RESPECT TO BODY
C
  627 CONTINUE
      DO 645 K=1,NWBP
      IC=K
      IF (NVLIN.EQ.0.OR.ITAIL.EQ.1) GO TO 606
      READ (7,746) IC,XCP,YCP,ZCP,VVEL(IC),WVEL(IC)
      WRITE (6,705) IC,XCP,YCP,ZCP,VVEL(IC),WVEL(IC)
  606 CONTINUE
      VEXT=-SINBET+BDV(K)+VVRTX(K)+VVEL(IC)
      WEXT=SINALF+BDW(K)+WVRTX(K)+WVEL(IC)
      IF (K.GT.NPANLS) GO TO 603
      IF(K.LE.NRP) GO TO 641
      IF(K.LE.NLP) GO TO 642
      IF(K.LE.N3P) GO TO 643
      IF(K.LE.NPANLS) GO TO 644
  603 RHS(K)=0.0
      GO TO 645
  641 PHIF=PHIFR*DTOR
      CALL ROTWF(VEXT,WEXT,VV,WW,PHIF)
      RHS(K)=-WW-SIN(RDELR)
      GO TO 645
  642 PHIF=PHIFL*DTOR
      CALL ROTWF(VEXT,WEXT,VV,WW,PHIF)
      RHS(K)=-WW-SIN(RDELL)
      GO TO 645
  643 PHIF=PHIFU*DTOR
      CALL ROTWF(VEXT,WEXT,VV,WW,PHIF)
      RHS(K)=-WW-SIN(RDELU)
      GO TO 645
  644 PHIF=PHIFD*DTOR
      CALL ROTWF(VEXT,WEXT,VV,WW,PHIF)
      RHS(K)=-WW-SIN(RDELD)
  645 CONTINUE
  646 CONTINUE
C
C     ADD IN PERTURBATION VELOCITY COMPONENTS INDUCED BY FIN
C     SOURCE PANELS AT THE BODY INTERFERENCE PANEL CONTROL POINTS.
C
      IF(NTOAT.EQ.0.OR..NOT.BODY) GO TO 91
      IIT=1
      IFT=NTHP
      DO 90 K=NPANLP,NWBP
      MJ=K
      CALL THKVEL(XCPT(K),YCPT(K),ZCPT(K))
      KB=K-NPANLS
      THU(KB)=UTCHK
      THV(KB)=VTCHK
      THW(KB)=WTCHK
C
C     INFLUENCED PANEL IS A BIP.  RESOLVE WING-FRAME
C     VELOCITIES INTO BIP FRAME.
C
      CALL ROTWB(VTCHK,WTCHK,VT,WT,KB)
      RHS(K)=RHS(K)-WT
   90 CONTINUE
      GO TO 92
   91 DO 93 K=NPANLP,NWBP
      KB=K-NPANLS
      THU(KB)=0.0
      THV(KB)=0.0
```

```
   93 THW(KB)=0.0
   97 CONTINUE
C
      IF (NOUT.NE.0) WRITE (6,728)
      IF (NOUT.EQ.0) GO TO 648
      WRITE(6,729) (K,RHS(K),K=1,NWBP)
  648 CONTINUE
      CALL SOLVE(RHS,FVN,NWBP)
      IF (NOUT.NE.0) WRITE(6,731)
      DO 630 I=1,NWBP
      DEMONP=RHS(I)*CONST
      DELTP(I)=DEMONP
      IF (ABS(DELTP(I)).LT.1.0E-10) DELTP(I)=0.0
      IF (NOUT.EQ.0) GO TO 630
      WRITE(6,729) I,DELTP(I)
  630 CONTINUE
C*********************************************************************
C     REDUCE REQUIRED CORE ALLOCATION BACK TO LFL SIZE              *
C                                                                    *
      CALL REQFL(LFL)
C                                                                    *
C*********************************************************************
C
C     PRINT CONTROL POINT COORDINATES OF THE CONSTANT U-VELOCITY PANELS
C     ON THE WING OR FIN SURFACES AND THE EXTERNALLY INDUCED
C     VELOCITIES AT THE CONTROL POINTS.
C
C
      WRITE(6,704) NCW,MSWR,MSWL,MSWU,MSWD
      WRITE(6,705) (J,XCPT(J),YCPT(J),ZCPT(J),BDU(J),BDV(J),BDW(J),
     1VVRTX(J),WVRTX(J),J=1,NPANLS)
      IF(.NOT.BODY) GO TO 655
      WRITE(6,725)
      DO 650 K=NPANLP,NWBP
  650 WRITE(6,705) K,XCPT(K),YCPT(K),ZCPT(K),THU(K-NPANLS),
     1       THV(K-NPANLS),THW(K-NPANLS)
  655 CONTINUE
C
C
C
C     CALCULATE LOADINGS ON THE WINGS OR FINS WITH LINEAR PRESSURE
C     LOADINGS
C
      IF (NPRESS.EQ.0) CALL LOADS
C
C
C     NON LINEAR PRESSURE LOADING CALCULATION
C     NVRTPL=0 MEANS EXCLUDE VORTEX INDUCED VELOCITIES PARALLEL TO WING
C     SURFACES
C
C
C
      IF (NOLINP.NE.0) CALL SPECPR
C
C     CONTINUE CALCULATION OF PRESSURES ON THE BODY MERIDIANS IN THE
C     REGION AFT OF LEADING EDGES OF FIN-BODY JUNCTIONS.
C     BDYAFT IS ENTRY POINT IN SUBROUTINE BDYPR
C
      IF (BODY.AND.NBDYPR.NE.0) CALL BDYAFT(ITAIL,XSTART)
C
C
      GO TO 999
      END
```

```
      SUBROUTINE BDYGEN                                                 DM02
C                                                                       DM02
C     VERSION1DEMON2.                                                   DM02
C                                                                       DM02
C   THIS SUBROUTINE DETERMINES STRENGHTS OF SUPERSONIC LINEARLY         DM02
C       VARYING LINE SOURCES/SINKS AND LINE DOUBLETS TO MODEL A BODY OF DM02
C     REVOLUTION AT GIVEN INCLUDED ANGLE OF ATTACK AND MACH NUMBER.     DM02
C                                                                       DM02
      DIMENSION A(100)                                                  DM02
C                                                                       DM02
      LOGICAL ASYM,DUMBDY,DELTA,NOSYM                                   DM02
C                                                                       DM02
      COMMON/ONE/DUM1(6402),ALFR,ARWING,B2,DUM2(9),FMACH,RB,DUM3(3),    DM02
     1 TLRNC,TIPY,TOTLR,DUM4(18) ,                                      DM02
     2  NBIP,DUM5(2),NDRAG,DUM6(4),NOCPT,NOLINP,NOUT,NPANLS,NPRESS,NWBP,DM02
     2ASYM,DUMBDY,DELTA,NOSYM                                           DM02
      COMMON/TWO/TX(101),UBD(101),UBS(101),VBD(101),VBS(101),VTBD(101), DM02
     1XBODY(101),RBODY(101),RPBODY(101),DRDX(100),T(100),TC(100),COEFF  DM02
     2(5),BCODE,BETASQ,BSQ,RADIUS,RFIELD,DUM7 ,U,V,VT,LNOSE,MACH,MACHSQ,DM02
     3BETA,XFIELD,X2,LBODY,NXBODY                                       DM02
      COMMON/WBTR/THTI(125),XWLE                                        DM02
      COMMON/SPSANG/SINALC,COSALC,SINPHI,COSPHI                         DM02
      COMMON/WBTR1/XF(100),RF(100)                                      DM02
C                                                                       DM02
C                                                                       DM02
      REAL MACH,MACHSQ,LNOSE,LBODY,LBODYR                               DM02
C                                                                       DM02
      INTEGER BCODE                                                     DM02
C                                                                       DM02
C                                                                       DM02
      NAMELIST/BODY/NXBODY,LNOSE,LBODY,BCODE                            DM02
C                                                                       DM02
C                                                                       DM02
C                                                                       DM02
    6 FORMAT(I4,F9.4,10G11.4)                                           DM02
  227 FORMAT(1H0,63HVELOCITIES INDUCED ON BODY BY BODY LINE SINGULARITIEDM02
     1S FOR MACH=,F7.4,5X,6HALFAC=,F7.4//20X,12HBODY SOURCES,25X,13HBODYDM02
     2 DOUBLETS,//9X,1HX,5X,1HU,10X,1HV,10X,2HVN,9X,1HU,9X,1HV,10X,     DM02
     3 2HVT, 9X,2HVN/)                                                  DM02
  700 FORMAT(1X,8(1H=),22HBODY DEFINITION POINTS,7(1H=),3X,10(1H=),     DM02
     1 14HCONTROL POINTS,9(1H=)/3X,1HI,6X,5HXBODY,6X,5HRBODY,5X,        DM02
     2  6HRPBODY,12X,2HXF,9X,2HRF,6X,5HDR/DX//)                         DM02
  701 FORMAT(1X,I3,1X,F10.4,1X,F10.4,1X,F10.4,4X,F10.4, 1X,F10.4,1X,    DM02
     1  F10.4)                                                          DM02
  702 FORMAT(20X,20H***REVISED LAYOUT***/)                              DM02
  703 FORMAT(1H1)                                                       DM02
  704 FORMAT (//,9X,54HBODY MERIDIAN-BODY NOSE MACH CONE INTERSECTION ATDM02
     1 XI= ,F10.5/)                                                     DM02
  799 FORMAT(1H1,89HPHYSICAL DIMENSIONS OF BODY AND LINE SINGULARITY STRDM02
     1ENGTHS REPRESENTING THE BODY AT MACH=,F7.4,5X,7HALFAC= ,F7.4/     DM02
     2 9X,1HX,12X,1HR,11X,5HDR/DX,12X,2HTX,10X,4HT(I),10X,5HTC(I))      DM02
  801 FORMAT(I4,F9.4, 6G15.5)                                           DM02
  802 FORMAT (1H1,48HBODY RADIUS TOO LARGE IN RELATION TO BODY LENGTH//)DM02
  803 FORMAT(///5X,63HMACH CONE-BODY MERIDIAN INTERSECTION NOT FOUND AFTDM02
     1ER 100 TRIALS///)                                                 DM02
C                                                                       DM02
C                                                                       DM02
      MACH=FMACH                                                        DM02
      RADIUS=RB                                                         DM02
C                                                                       DM02
C     READ NAMELIST BODY                                                DM02
C                                                                       DM02
```

```
      READ(5,BODY)
C
C
      WRITE(6,BODY)
      IF(NXBODY.LE.0.OR.NXBODY.GT.101)NXBODY=51
C
C
C     INITIALIZE DOUBLET STRENGHTS
C
      DO 103 I=1,NXBODY
  103 TC(I)=0.0
C
C CALCULATION OF AERODYNAMIC DATA
C
      MACHSQ=MACH*MACH
      BETASQ=MACHSQ-1.0
      BETA=SQRT(BETASQ)
      ALPHA=ASIN(SINALC)
      ALFAC=ALPHA*57.2957795
      N=NXBODY-1
      XBODY(1)=0.0
      XBODY(NXBODY)=LBODY
C
C
C     BAIL OUT IF MACH CONE FROM NOSE TIP LIES INSIDE THE ENTIRE LENGTH
C     OF THE BODY
C
      IF (BETA*RADIUS.GE.LBODY) GO TO 200
      GO TO 204
  200 WRITE (6,802)
      STOP
  204 CONTINUE
C
C SETUP OF POINTS ON BODY AXIS BY DIVIDING BODY LENGTH INTO N  EQUAL
C SEGMENTS
C
      DEL=LBODY/N
      DO 33 I=2,N
   33 XBODY(I)=XBODY(I-1)+DEL
C
C
C     CALCULATION OF BODY RADII AND STREAM WISE SLOPES AT THE X-STATIONS
C     OF THE AXIS POINTS.
C     THEY ARE THE COORDINATES AND SLOPE AT THE BODY DEFINITION POINTS
C
      DO 35 I=1,NXBODY
   35 CALL BODYR(XBODY(I)        ,RBODY(I),RPBODY(I))
C
C     NOW DETERMINE SLOPES DR/DX AT THE CONTROL POINTS TAKEN MID-WAY
C     BETWEEN THE BODY DEFINITION POINTS
C
      DO 36 I=1,N
      XF(I)=.5*(XBODY(I+1)+XBODY(I))
      CALL BODYR(XF(I),RF(I),DRDX(I))
   36 CONTINUE
      IF(NOUT.NE.1) GO TO 9
      WRITE(6,703)
      WRITE(6,700)
      WRITE(6,701) (I,XBODY(I),RBODY(I),RPBODY(I),XF(I),RF(I),
     1  DRDX(I),I=1,N)
      WRITE(6,701) NXBODY,XBODY(NXBODY),RBODY(NXBODY),RPBODY(NXBODY)
    9 CONTINUE
C
```

```
C NEXT LOOP DETERMINES THE LOCATIONS OF THE ORIGINS OF THE LINEARLY
C VARYING LINE SOURCES/SINKS AND DOUBLETS.
C THEIR STARTING POINTS ARE GIVEN BY TX(I)
C
      DO 10 I=1,NXBODY
   10 TX(I)=XBODY(I)-BETA*RBODY(I)
C
C  IF CONTROL POINTS LIE OUTSIDE THE MACH CONE WITH ITS ORIGIN AT THE
C  BODY NOSE, REVISE LAY-OUT OF BODY DEFINITION POINTS ETC.
C
      IF(BETA*RF(1).LT.XF(1))GO TO 199
C
C     DETERMINE X-STATION OF INTERSECTION OF BODY NOSE MACH CONE
C     WITH BODY
C
      DO 37 I=2,N
      IF((BETA*RF(I)-XF(I)).LT.0.0)  GO TO 38
   37 CONTINUE
   38 IAFT=I
      IBFR=I-1
      DELTX=(XF(IAFT)-XF(IBFR))*0.1
      ITRY=0
      XTRY=XF(IBFR)
   40 RMCNE=XTRY/BETA
      CALL BODYR(XTRY,RI,SLPE)
      ITRY=ITRY+1
      ERR=RI-RMCNE
      IF(ITRY.GE.100) GO TO 42
      IF(ERR.LT.0.0) GO TO 39
      XTRY=XTRY+DELTX
      GO TO 40
   42 WRITE(6,803)
      STOP
   39 IF(ABS(ERR).LT.(.01*RI)) GO TO 41
      XTRY=XTRY-DELTX
      DELTX=0.1*DELTX
      GO TO 40
   41 XI=XTRY
C
C     REVISE LAYOUT OF BODY DEFINITION POINTS, CONTROL POINTS, AND
C     ORIGINS OF LINE SINGULARITIES
C
      LBODYR=LBODY-XI
      DEL=LBODYR/N
      XBODY(2)=XI+DEL
      DO 43 I=3,N
   43 XBODY(I)=XBODY(I-1)+DEL
C
      DO 44 I=1,NXBODY
   44 CALL BODYR(XBODY(I),RBODY(I),RPBODY(I))
C
      XF(1)=0.5*(XI+XBODY(2))
      CALL BODYR(XF(1),RF(1),DRDX(1))
      DO 45 I=2,N
      XF(I)=0.5*(XBODY(I)+XBODY(I+1))
      CALL BODYR(XF(I),RF(I),DRDX(I))
   45 CONTINUE
      IF(MOUT.NE.1) GO TO 455
      WRITE(6,703)
      WRITE(6,702)
      WRITE (6,704) XI
      WRITE(6,700)
```

```
      WRITE(6,701) (I,XBODY(I),RBODY(I),RPBODY(I),XF(I),RF(I),
     1  DRDX(I),I=1,N)
      WRITE(6,701) NXBODY,XBODY(NXBODY),RBODY(NXBODY),RPBODY(NXBODY)
  455 CONTINUE
      TX(1)=0.0
      DO 46 I=2,NXBODY
   46 TX(I)=XBODY(I)-BETA*RBODY(I)
  199 CONTINUE
C
C     DETERMINATION OF SOURCE STRENGTHS AT CONTROL POINTS MIDWAY BETWEEN
C      BODY DEFINITION POINTS.
C
C CALCULATION OF THE FIRST SOURCE STRENGTH.
C
      XFIELD=XF(1)
      RFIELD=RF(1)
      SLOPE=DRDX(1)
      RSQ=BETASQ*RFIELD*RFIELD
      X2=XFIELD-LBODY
      CALL SOURCE(1)
      A(1)=V-SLOPE*U
      T(1)=DRDX(1)/A(1)
C
C CALCULATION OF THE REST OF SOURCE STRENGTHS.
C
      DO 210 I=2,N
      XFIELD=XF(I)
      RFIELD=RF(I)
      SLOPE=DRDX(I)
      RSQ=BETASQ*RFIELD*RFIELD
      X2=XFIELD-LBODY
      DO 205 J=1,I
      CALL SOURCE(J)
  205 A(J)=V-SLOPE*U
      SUM=0.
      IM1=I-1
      DO 201 J=1,IM1
  201 SUM=T(J)*A(  J)+SUM
  210 T(I)=(DRDX(I)-SUM)/A(I)
      T(NXBODY)=0.0
C
C     DETERMINATION OF DOUBLET STRENGTHS AT CONTROL POINTS MIDWAY
C      BETWEEN BODY DEFINITION POINTS
C
C CALCULATION OF THE FIRST DOUBLET STRENGTH.
C
      IF (ABS(ALPHA).LT.1.0E-10.OR.RB.LT.(0.1*R2)) GO TO 798
      XFIELD=XF(1)
      RFIELD=RF(1)
      SLOPE=DRDX(1)
      RSQ=BETASQ*RFIELD*RFIELD
      X2=XFIELD-LBODY
      CALL DOUBLT(1)
      A(1)=SLOPE*U-V
      TC(1)=ALPHA/A(1)
C
C CALCULATION OF THE REST OF THE DOUBLET STRENGTHS.
C
      DO 215 I=2,N
      XFIELD=XF(I)
      RFIELD=RF(I)
      SLOPE=DRDX(I)
      RSQ=BETASQ*RFIELD*RFIELD
```

```
      X2=XFIELD-LBODY
      DO 212 J=1,I
      CALL DOUBLT(J)
  212 A(  J)=SLOPE*U-V
      SUM=0.
      IM1=I-1
      DO 203 J=1,IM1
  203 SUM=TC(J)*A(  J)+SUM
  215 TC(I)=(ALPHA-SUM)/A(I)
      TC(NXBODY)=0.0
  798 CONTINUE
C
C PRINT OUT OF BODY CHARACTERISTICS
C
      WRITE(6,799)MACH,ALFAC
      DO 800 I=1,NXBODY
  800 WRITE(6,801) I,XBODY(I),RBODY(I),RPBODY(I),TX(I),T(I),TC(I)
C
C COMPUTATION OF VELOCITIES INDUCED ON BODY BY BODY SOURCES AND
C DOUBLETS AT BODY DEFINITION POINTS, THT=0 DEGR. MEANS LEEWARD SIDE
C
      IF(NOUT.EQ.0) RETURN
      WRITE(6,227)MACH,ALFAC
C
C     COSTH,SINTH ARE COSINE AND SINE,RESPECTIVELY, OF THE STREAMWISE
C     BODY SLOPE ANGLE.
C
      DO 225 I=1,NXBODY
      COSTH=SQRT(1./(RPBODY(I)**2+1.))
      SINTH=SQRT(1.-COSTH*COSTH)
      XFIELD=XBODY(I)
      RFIELD=RBODY(I)
      IF(RFIELD.GT.0.   )GO TO 214
C
C  IF THE FIELD POINT IS ON THE AXIS, THEN WE SHIFT OUT TO AVOID THE
C   SINGULARITY IN THE VELOCITY FUNCTION ON THE AXIS.
C
      IF(I.EQ.NXBODY)GO TO 221
      RFIELD=RBODY(I+1)/10.
      XFIELD=XFIELD+(XBODY(I+1)-XBODY(I))/10.
      GO TO 214
  221 RFIELD=RBODY(I-1)/10.
      XFIELD=XFIELD-(XBODY(I)-XBODY(I-1))/10.
  214 RSQ=BETASQ*RFIELD*RFIELD
      X2=XFIELD-LBODY
C
C     VELOCITIES UD,VD ARE CALCULATED ON THE BODY OPPOSITE THE CROSS
C     FLOW STREAM VECTOR (LEEWARD SIDE)
C     VELOCITY VTD IS CALCULATED AT 90 DEGREES FROM THE CROSS FLOW
C     STREAM DIRECTION
C
      US=0.
      VS=0.
      UD=0.
      VD=0.
      VTD=0.
      DO 218 J=1,I
      CALL SOURCE(J)
      US=US+T(J)*U
      VS=VS+T(J)*V
      CALL DOUBLT(J)
      UD=UD+U*TC(J)
      VD=VD+V*TC(J)
```

```
C
C     VNS,VND ARE INDICATORS OF LEAKAGE THROUGH THE BODY SURFACE
C     AT THE BODY DEFINITION POINTS.
C NOTE: THE BOUNDARY CONDITION IS SATISFIED AT THE CONTROL POINTS IN
C     BETWEEN THE BODY DEFINITION POINTS.
C
  218 VTD=VTD+VT*TC(J)
      IF(RPBODY(I).LT.0.)GO TO 220
      VNS=VS*COSTH-(1.+US)*SINTH
      VND=(VD+ALPHA)*COSTH-UD*SINTH
      GO TO 222
  220 VNS=VS*COSTH+(1.+US)*SINTH
      VND=(VD+ALPHA)*COSTH+US*SINTH
  222 UBS(I)=US
      VBS(I)=VS
      UBD(I)=UD
      VBD(I)=VD
      VTBD(I)=VTD
  225 WRITE(6,6) I,XBODY(I),US,VS,VNS,UD,VD,VTD,VND
      RETURN
      END


      SUBROUTINE BDYPR(ITAIL,XSTART)
C
C     VERSION:DEMON2.
C
C     THIS SUBROUTINE COMPUTES LINEAR AND BERNOULLI PRESSURES AT POINTS
C     ON THE BODY SURFACE.
C     THE POINTS LIE ON BODY MERIDIANS. THEIR X-COORDINATES ARE A SUBSET
C     OF THE X-COORDINATES OF THE BODY CONTROL POINTS (XF(I),RF(I))
C     DETERMINED IN SUBROUTINE BDYGEN.
C     THE DENSITY OF THE POINTS IS TAKEN AS HALF THE DENSITY OF
C     THE BODY SINGULARITIES.
C     WHERE THE BODY
C     IS COVERED WITH INTERFERENCE PANELS, THE POINTS COINCIDE WITH
C     THE PANEL CONTROL POINTS.  THE BODY MERIDIANS ON WHICH THE
C     POINTS LIE PASS THROUGH THE CONTROL POINTS OF THE BODY
C     INTERFERENCE PANELS.  THE NUMBER OF BODY MERIDIANS IS EQUAL TO
C     NBDCR, THAT IS, THE NUMBER OF BODY INTERFERENCE PANELS ON THE
C     BODY CIRCUMFERENCE.
C
C
C
      DIMENSION THETD(100)
C
C
      LOGICAL BODY,NOSYM
C
C
      COMMON/ONE/CIRC(250),DELTP(250),FN(250),PNLC(250),SWPPLE(250),
     1SWPPTE(250),VNOR(250),XBAR(250),ZBAR(250),XCPT(250),YCPT(250),ZCPT
     2(250),XLF(250),XLB(250),XRF(250),XRB(250),YLC(250),YRC(250),ZLF(250
     3),ZRF(250),ZLB(250),ZRB(250),SNT(125),CST(125),SNT2(125),CST2(125
     4),IP(300),XFBIP(100),A,ALFA,ALFR,ARWING,B2,B2V,BETA,BETAR,CONST,
     5COSALF,COSBET,CN,DX,EM,FMACH,RCIR,SINALF,SINBET,SLOPE,TLRNC,TIPY,
     6TOTLR,U,V,W,UCHK,VCHK,WCHK,WBIP,X,Y,Z,I,IF,IT,J,MSWR,MSWL,MSWU,
     7MSWD,NBIP,NCRX,NCW,NDRAG,NHP,NPR,NRP,N3P,NOCPT,NOLINP,NOUT,NPANLS,
     8NPRESS,NWRP,ASYM,BODY,DELTAS,NOSYM
      COMMON/SWEEPS/VSWLER(20),VSWTER(20),VSWLEL(20),VSWTEL(20),
     1  VSWLEU(20),VSWTEU(20),VSWLED(20),VSWTED(20),LVSWP,LEFT,FAC,NCWB,
```

```
     2ARPNL(250),WIDTH(250)
      COMMON/BVEL/BDU(150),BDV(150),BDW(150),XFLDP(150),YFLDP(150),
     1 ZFLDP(150)
      COMMON/SPSANG/SINALC,COSALC,SINPHI,COSPHI
      COMMON/WHTR/THTI(125),XWLE
      COMMON/TWO/TX(101),UBD(101),UBS(101),VBD(101),VBS(101),VTHD(101),
     1XBODY(101),RBODY(101),RPBODY(101),DRDX(100),T(100),TC(100),COEFF
     2(5),BCODE,BETASQ,BSQ,RADIUS,RFIELD,RNOSE,DUMVEL(3),LNOSE,MACH,
     3MACHSQ,DMBETA,XFIELD,X2,LBODY,NXBODY
      COMMON /WBTR1/ XF(100),RF(100)
      COMMON/VRTXV/VVRTX(150),WVRTX(150),NVRTPL,NVRTX,VRTMAX
      COMMON/THKDAT/NTDAT,NCWT,NTPR,MSWT(4),NRPT,NHPT,N3PT,NTHP,ASYMT,
     1      NVERT,SWLET(20,4),SWTET(20,4),YTH(20,4),THETAL(400)
      COMMON/ICVEL/UTCHK,VTCHK,WTCHK,IIT,IFT,MJ
      COMMON/VPTHVL/VVEL(500),WVEL(500),JCPT,NCPOUT,NVLIN
      COMMON/VORSPC/GAMMA(10),YVRTX(10),ZVRTX(10),RLOC
      COMMON/ELLIPS/RA,RB,ERATIO
C
C
      REAL LBODY
C
C
      DATA RADTOD/57.2957795/
C
C
C
  700 FORMAT(1H1,25X,49HPRESSURE COEFFICIENTS AT POINTS ON BODY MERIDIAN
     13//)
  701 FORMAT (//45X,10HBODY RING=,1X,I3/)
  702 FORMAT(1X,I3,12F10.5)
  703 FORMAT (2X,1HJ,4X,6HTHETA,,6X,2HXB,6X,2HYB,8X,2HZB,8X,4HUTOT,6X,
     1 4HVTOT,6X,4HWTOT,4X,7HCP,LIN,,3X,8HCP,BERN,,3X,5HDP/DX,5X,
     2 7HP/PINF,,3X,7HP/PINF,/8X,4HDEG,,97X,5HBERN,,5X,4HLIN,/)
  704 FORMAT (1H1,106(1H*)/1X,37HAFT OF LEADING EDGE OF FIN ROOTCHORDS)
  705 FORMAT (1X,I5,3(2X,F10.5),2(2X,E12.5))
  706 FORMAT (/40X,46HRIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= ,
     1 F10.5/
     2           40X,46HRIGHT VORTEX Y(ROLLED COORDS.)/RLOC           = ,
     3  F10.5/
     4           40X,46HRIGHT VORTEX Z(ROLLED COORDS.)/RLOC           = ,
     5 F10.5/
     6           40X,46HLEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = ,
     7 F10.5/
     8           40X,46HLEFT VORTEX Y(ROLLED COORDS.)/RLOC            = ,
     9 F10.5/
     1           40X,46HLEFT VORTEX Z(ROLLED COORDS.)/RLOC            = ,
     2 F10.5/)
  745 FORMAT (I5,3E12.5)
  746 FORMAT (I5,5E12.5)
  747 FORMAT (///10X,38HTOTAL NUMBER OF PRESSURE POINTS,JCPT= ,I4)
  748 FORMAT (1H1,10X,73HPOINT COORDINATES AND PERTURBATION VELOCITIES C
     1ALCULATED BY PROGRAM VPATH//,
     2 5X,2HIC,5X,3HXCP,9X,3HYCP,9X,3HZCP,8X,8HVVEL(IC),6X,8HWVEL(IC)/)
C
C
C
      IF (.NOT.BODY) RETURN
      FACTR1=1.428571429/(FMACH*FMACH)
      FACTR2=0.2*FMACH*FMACH
      DEGTOR=1.0/RADTOD
      ALFAC=ASIN(SINALC)*RADTOD
      THETAN=ATAN(RPBODY(1))*RADTOD
      FINE=XWLE/(2.0*RB)
      XA=XWLE/RB
```

```
      NOCPT=1
C
C
C NOTE: UP TO ENTRY BOYAFT,FOLLOWING APPLIES TO CIRCULAR CROSS SECTION
C     BODIES ONLY.
C     SET UP ARRAY OF COORDINATES IN WING COORDINATE SYSTEM FOR
C     THE PRESSURE POINTS AHEAD OF THE WING- OR FIN-BODY JUNCTION.
C     CALCULATE VELOCITY COMPONENTS IN BODY COORDINATE SYSTEM.
C     THEN CALCULATE PRESSURE COEFFICIENTS.
C
C     READ IN PERTURBATION VELOCITIES CALCULATED BY PROGRAM VPATH2
C     IF NVLIN IS NOT ZERO.
C     ONLY APPLICABLE WHEN TAIL IS UNDER CONSIDERATION.
C
      IF (NVLIN.EQ.0.OR .ITAIL.EQ.0) GO TO 8
      REWIND 7
      WRITE (6,748)
      DO 9  I=1,JCPT
      READ (7,746) IC,XCP,YCP,ZCP,VVEL(IC),WVEL(IC)
    9 WRITE (6,705) IC,XCP,YCP,ZCP,VVEL(IC),WVEL(IC)
    8 CONTINUE
C
      WRITE(6,700)
      WRITE (6,703)
      NRING=NBIP/NC*8
      NRINGD=2*NRING
      IF (.NOT.NOSYM) NRINGD=NRINGD+1
      NHALF=NXBODY/2
      DTHETA=THTI(1)/2.0
      ANBODY=NXBODY
      DELX=LBODY/(ANBODY-1.0)
      IF (ITAIL.EQ.1) GO TO 5
      JCPT=0
      ISTART=1
      IL=0
      GO TO 6
    5 JCPT=NWBP
      ISTART=(XSTART/(DELX*2.0))+2
    6 CONTINUE
C
C
C
C     WRITE DATA-SET CONTAINING CONTROL POINTS.
C
      IF (ITAIL.EQ.0.AND.NCPOUT.EQ.0) GO TO 7
      DO 21 IXSTAT=ISTART,NHALF
      ICPT=(IXSTAT-1)*2+1
      XPT=XF(ICPT)-XWLE
      IF (XPT.GE.0.0) GO TO 22
      DO 23 J=1,NRINGD
   23 JCPT=JCPT+1
   21 CONTINUE
   22 CONTINUE
      WRITE(6,747) JCPT
      REWIND 4
      WRITE(4,745) JCPT
      WRITE(4,745) (J,XCPT(J),YCPT(J),ZCPT(J),J=1,NWBP)
      JCPT=NWBP
    7 CONTINUE
C
C
      DO 10 IXSTAT=ISTART,NHALF
      ICPT=(IXSTAT-1)*2+1
      XPT=XF(ICPT)-XWLE
```

```
      IF(XPT.GE.0.0) GO TO 13
      WRITE(6,701) IXSTAT
      DO 11 JPOLAR=1,NRING
      JDBLE=JPOLAR*2
      JDM1=JDBLE-1
      THETD(JDM1)=THTI(JPOLAR)-DTHETA
      THETD(JDBLE)=THTI(JPOLAR)
      THETEV=THETD(JDBLE)*DEGTOR
      THETOD=THETD(JDM1)*DEGTOR
      YPTEV=RF(ICPT)*COS(THETEV)
      YPTOD=RF(ICPT)*COS(THETOD)
      ZPTEV=RF(ICPT)*SIN(THETEV)
      ZPTOD=RF(ICPT)*SIN(THETOD)
C
C   NOTE: XFLDP,YFLDP,ZFLDP ARE IN THE WING COORDINATE SYSTEM.
C
      XFLDP(JDM1)=XPT
      XFLDP(JDBLE)=XPT
      YFLDP(JDM1)=YPTOD
      YFLDP(JDBLE)=YPTEV
      ZFLDP(JDM1)=ZPTOD
   11 ZFLDP(JDBLE)=ZPTEV
C
C     IF TRUSYM IS TRUE, ADD FIELDPOINT AT 270 DEGREES
C     TO COORDINATE ARRAYS.
C
      IF(NOSYM) GO TO 25
      DO 20 J=1,NRING
      JJ=NRINGD-J
      XFLDP(JJ+1)=XFLDP(JJ)
      YFLDP(JJ+1)=YFLDP(JJ)
      ZFLDP(JJ+1)=ZFLDP(JJ)
      THETD(JJ+1)=THETD(JJ)
   20 CONTINUE
      XFLDP(NRING+1)=XPT
      YFLDP(NRING+1)=0.0
      ZFLDP(NRING+1)=-RF(ICPT)
      THETD(NRING+1)=270.0
   25 CONTINUE
C
C     COMPUTE CONTRIBUTION TO VELOCITIES FROM BODY SINGULARITIES.
C     BDU, BDV, BDW.
C
      CALL VELCAL (NRINGD,ALFR,BETAR,1)
C
C   NOTE: AHEAD OF THE FIN-BODY JUNCTION,NO INFLUENCE FROM CONSTANT
C     U-VELOCITY OR SOURCE PANELS.
C
C
C     ADD CONTRIBUTION FROM NOSE VORTICES IF APPLICABLE.
C     THEIR INFLUENCE IS LIMITED TO THE DISTANCE ALONG THE BODY UP TO
C     THE ROOTCHORD LE OF THE CANARDS.
C
      IF (ITAIL.EQ.1) GO TO 19
      IF (ABS(ALFAC).LE.4.0) GO TO 19
      XGAMN=XF(ICPT)/RB
      RLOC=RF(ICPT)
      CALL BDYVTX (ALFAC,THETAN,FINE,XA,FMACH,GAMN,1,XGAMN,YGAMN,
     1 ZGAMN,XSA,IL)
      IF (GAMN.EQ.0.0) GO TO 19
      NVRT=NVRTX
      NVRTX=2
      GAMMA(1)=GAMN
      GAMMA(2)=-GAMN
```

```
      YVRTX(1)=-ZGAMN*SINPHI+YGAMN*COSPHI
      YVRTX(2)=-ZGAMN*SINPHI-YGAMN*COSPHI
      ZVRTX(1)=ZGAMN*COSPHI+YGAMN*SINPHI
      ZVRTX(2)=ZGAMN*COSPHI-YGAMN*SINPHI
      WRITE (6,706) GAMMA(1),YVRTX(1),ZVRTX(1),
     1              GAMMA(2),YVRTX(2),ZVRTX(2)
      NOCPT=1
      CALL VORTEX (1,NRINGD)
      NVRTX=NVRT
   19 CONTINUE
C
C     PRESSL=LINEAR PRESSURE COEFFICIENT
C     PRESSB=BERNOULLI PRESSURE COEFFICIENT
C
      DO 12 J=1,NRINGD
      JCPT=JCPT+1
      IC=JCPT
      XBDY=XFLOP(J)+XWLE
      IF (NOUT.NE.0)
     1WRITE (6,702) J,THETD(J),XBDY,YFLOP(J),ZFLOP(J),BDU(J),BDV(J),
     1 BDW(J)
      UTOT=BDU(J)
      VTOT=BDV(J)+VVRTX(J)
      WTOT=BDW(J)+WVRTX(J)
      IF (NOUT.NE.0)
     1WRITE (6,702) J,THETD(J),XBDY,YFLOP(J),ZFLOP(J),UTOT,VTOT,WTOT
      VTOT=VTOT+VVEL(IC)
      WTOT=WTOT+WVEL(IC)
      IF (NOUT.NE.0)
     1WRITE (6,702) J,THETD(J),XBDY,YFLOP(J),ZFLOP(J),UTOT,VTOT,WTOT
      PRESSL=-2.0*UTOT
      BDUSQ=UTOT*UTOT
      BDVSQ=VTOT*VTOT
      BDWSQ=WTOT*WTOT
      UBAR=UTOT*COSALC-VTOT*SINBET+WTOT*SINALF
      ARG=1.0-FACTR2*(2.0*UBAR+BDUSQ+BDVSQ+BDWSQ)
      PRESSB=-FACTR1
      IF(ARG.GE.TOTLR) PRESSB=FACTR1*(ARG**3.5-1.0)
      POPINF=PRESSB/FACTR1+1.0
      PLINOP=PRESSL/FACTR1+1.0
      WRITE(6,702) J,THETD(J),XBDY,YFLOP(J),ZFLOP(J),UTOT,VTOT,WTOT,
          PRESSL,PRESSB,DRDX(ICPT),POPINF   ,PLINOP
C
C
C     FINISH WRITING DATA-SET WITH BODY PRESSURE POINTS.
C     APPLICABLE ONLY WHEN ITAIL=1 AND NCPOUT.NE.0.
C
C NOTE: THEY ARE SPECIFIED IN THE WING COORDINATE SYSTEM.
C
      IF (ITAIL.EQ.1.AND.NCPOUT.NE.0)
     1                 WRITE (4,745) JCPT,XFLOP(J),YFLOP(J),ZFLOP(J)
C
      VVRTX(J)=0.0
      WVRTX(J)=0.0
   12 CONTINUE
   10 CONTINUE
   13 CONTINUE
      WRITE (6,747) JCPT
      RETURN
C
C     CALCULATE PRESSURE COEFFICIENTS AFT OF LEADING EDGE OF FIN-BODY
C     JUNCTION AT CONTROL POINTS OF BODY INTERFERENCE PANELS.
C     CONTROL POINT COORDINATES ARE IN WING SYSTEM.
```

```
C
      ENTRY BDYAFT
C
      WRITE (6,704)
      WRITE (6,700)
      WRITE (6,703)
      DO 14 IBD=1,NBIP
      JBD=IBD+NPANLS
      XFLDP(IBD)=XCPT(JBD)
      YFLDP(IBD)=YCPT(JBD)
   14 ZFLDP(IBD)=ZCPT(JBD)
C
C     COMPUTE CONTRIBUTION TO VELOCITIES FROM BODY SINGULARITIES, BDU,
C     BDV, BDW.
C     IF BODY HAS ELLIPTICAL CROSS SECTION,BDU,BDV,BDW ARE ALREADY READ
C     IN BY ROUTINE CRFWBD FROM A DATA SET.(SEE SUBROUTINE BDYRD)
C
      IF (RA.EQ.RB) CALL VELCAL (NBIP,ALFR,BETAR,1)
C
C
C     ADD EFFECTS OF 2-D TYPE VORTICES IF APPLICABLE
C     THEY HAVE BEEN CALCULATED ALREADY IN CRFWBD.
C     (BY MEANS OF SUBROUTINE VRTVEL OR VVELS)
C
      DO 18 K=1,NBIP
      KK=K+NPANLS
      IF (RA.EQ.RB) GO TO 16
      BDU(K)=BDU(KK)
      BDV(K)=BDV(KK)
      BDW(K)=BDW(KK)
   16 BDV(K)=BDV(K)+VVRTX(KK)
   18 BDW(K)=BDW(K)+WVRTX(KK)
C
C     ADD CONTRIBUTION FROM SOURCE PANELS ON WINGS
C
      IF(NTDAT.EQ.0) GO TO 35
      IIT=1
      IFT=NTHP
      DO 30 K=1,NBIP
      MJ=K
      CALL THKVEL(XFLDP(K),YFLDP(K),ZFLDP(K))
      BDU(K)=BDU(K)+UTCHK
      BDV(K)=BDV(K)+VTCHK
      BDW(K)=BDW(K)+WTCHK
   30 CONTINUE
   35 CONTINUE
C
C     CALCULATE CONTRIBUTION FROM CONSTANT U-VELOCITY PANELS ON BODY
C     INTERFERENCE SHELL AND WINGS OR FINS.
C     ADD IN VELOCITIES INDUCED BY MOVING VORTICES(IF APPLICABLE).
C
C
      IBD=0
      II=1
      IF=NWHP
      NRING=NBIP/NCWB
      DTHETA=THTI(1)/2.0
      FACTR1=1.428571429/(FMACH*FMACH)
      FACTR2=0.2*FMACH*FMACH
      DO 15 IL=1,NCWB
      WRITE (6,701) IL
      DO 17 JL=1,NRING
      IBD=IBD+1
```

```
      IC=NPANLS+IBD
      THTSD=THTI(JL)-DTHET.
      XBDY=XFLDP(IBD)+XWLE
      IF (NOUT.NE.0)
     1WRITE (6,702) JL,THTSD,XBDY,YFLDP(IBD),ZFLDP(IBD),BDU(IBD),
     1 BDV(IBD),BDW(IBD)
      CALL VFLNOR (XFLDP(IBD),YFLDP(IBD),ZFLDP(IBD))
      UTOT=UCHK+BDU(IBD)
      VTOT=VCHK+BDV(IBD)+VVEL(IC)
      WTOT=WCHK+BDW(IBD)+WVEL(IC)
      IF (NOUT.NE.0)
     1WRITE (6,702) JL,THTSD,XBDY,YFLDP(IBD),ZFLDP(IBD),UTOT,VTOT,
     1 WTOT
      PRESSL=-2.0*UTOT
      BDUSQ=UTOT*UTOT
      BDVSQ=VTOT*VTOT
      BDWSQ=WTOT*WTOT
      UBAR=UTOT*COSALC-VTOT*SINBET+WTOT*SINALF
      ARG=1.0-FACTR2*(2.0*UBAR+BDUSQ+BDVSQ+BDWSQ)
      PRESSB=-FACTR1
      IF(ARG.GE.TOTLR) PRESSB=FACTR1*(ARG**3.5-1.0)
      POPINF=PRESSB/FACTR1+1.0
      PLINOP=PRESSL/FACTR1+1.0
      SLP=0.0
      WRITE(6,702)JL,THTSD,XBDY,             YFLDP(IBD),ZFLDP(IBD),UTOT
     1,VTOT,WTOT,PRESSL,PRESSB,SLP,POPINF,PLINOP
   17 CONTINUE
   15 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BDYRD(BDU,BDV,BDW,NWBP,NPANLS,NAGAIN)
C
C     VERSION: DEMON2
C
C  ROUTINE TO READ ELLIPTICAL CROSS SECTION BODY INDUCED VELOCITIES
C     AT WING AND BODY INTERFERENCE SHELL.
C     THEY ARE READ IN FROM TAPE4.
C
      DIMENSION BDU(NWBP),BDV(NWBP),BDW(NWBP)
C
      COMMON/ELLIPS/RA,RB,ERATIO
C
  700 FORMAT (////,5X,54HBODY UNDER CONSIDERATION HAS ELLIPTICAL CROSS S
     1ECTION./
     2 5X,44HINTERFERENCE SHELL HAS FOLLOWING PROPERTIES:/
     3 5X,23HHORIZONTAL SEMI-AXIS = ,F10.5/
     4 5X,23HVERTICAL SEMI-AXIS   = ,F10.5////)
745   FORMAT(I5,3E12.5)
750   FORMAT(///,10X,24HWARNING - NWCPT,NF,NWBP,76X,12H** BDYRD ** //,
     *    7H NWCPT=,I5,7H XMACH=,F10.4,7H ALPHA=,F10.4)
C
C     READ PAST CONTROL POINT COORDINATES.
C
      IF (NAGAIN.LE.0) REWIND 4
      IF (NAGAIN.LE.0) READ (4,745) NDUM
      IF (NAGAIN.LE.0) READ(4,745) (I,XPTJ,YPTJ,ZPTJ,J=1,NWBP)
      WRITE (6,700) RB,RA
C
C
```

```
C   READ VELOCITY COMPONENTS
C
      READ(4,745) NWCPT,XMACH,XALPHA
      IF (NWCPT.NE.NWBP) WRITE(6,750) NWCPT,XMACH,XALPHA
      READ(4,745) (I,BDU(J),BDV(J),BDW(J),J=1,NWCPT)
      RETURN
      END


      SUBROUTINE BDYVTX (ALPHAD,THETAN,FINE,XA,EMACH,GAMN,NG,
     1                   XGAMN,YGAMN,ZGAMN,XSA,IL)
C
C     VERSION: DEMON2
C
C     FOR BODIES WITH CIRCULAR CROSS SECTION ONLY
C     THIS SUBROUTINE COMPUTES STRENGTH AND POSITION IN THE CROSS FLOW
C     PLANE OF THE BODY NOSE VORTICES AS A FUNCTION OF AXIAL DISTANCE.
C     THE METHOD USED IS BASED ON EXPERIMENTAL DATA.
C     REFERENCE IS NASA CR-2473,1975.
C
      DIMENSION XST(11),ZA1(11),YA1(11),YA2(11),GAMT(11)
C
      DATA XST/0.0,1.0,2.0,3.0,4.0,5.0,6.0,7.0,8.0,9.0,10.0/
      DATA GAMT/0.3,0.32,0.34,0.40,0.48,0.62,0.77,0.90,1.0,1.08,1.15/
      DATA YA1/.45,.463,.477,.492,.505,0.52,.534,0.55,0.565,0.575,0.585/
      DATA YA2/.63,.64,.653,.665,.678,.69,.7,.715,.725,.735,.74/
      DATA ZA1/1.14,1.26,1.38,1.5,1.615,1.73,1.84,1.95,2.05,2.14,2.20/
C
  701 FORMAT (//1X5H*****,3X62HASYMMETRIC OR UNSTEADY BODY VORTEX SEPARA
     1TION POSSIBLE    *****//)
  702 FORMAT (40X,41HBODY NOSE SEPARATION AT XB/RB             = ,F10.5/
     1 40X,    41HVORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = ,F10.5/
     2  40X,41HVORTEX Y/RLOC (UNROLLED COORDS)         = ,F10.5/
     3  40X,41HVORTEX Z/RLOC (UNROLLED COORDS)         = ,F10.5/)
C
      IF (IL.GE.1) GO TO 16
      BDYVRT=1.0
      NTABLE=11
      DELTA=0.0
      F=1.0
      IF (ALPHAD.LT.0.0) F=-1.0
      ALPHA=F*ALPHAD
C
C     XSA=XSEPARATION/RB
C
      IF (THETAN.LE.30.0) GO TO 10
      XSA=10./(ALPHA -4.0) + 2.0
      GO TO 13
   10 XSA=32.0 - SQRT(1024.0*(ALPHA -4.0)/(THETAN-4.0))
   13 IF (XSA.LT.0.0) XSA=0.0
      IL=IL+1
      IF(XSA.GE.XA) BDYVRT=0.0
      IF(BDYVRT.EQ.0.0) GO TO 31
      IF (XSA.GE.XA) GO TO 31
C
C      COMPUTE UPPER LIMIT FOR SYMMETRIC VORTEX SEPARATION
C
      ALMT=((FINE-12.0)**2)/3.57 + 12.0
      IF (ALPHA .GT.ALMT) WRITE (6,701)
      SNALP=SIN(ALPHAD/57.2957795)*F
   16 CONTINUE
      IF(BDYVRT.EQ.0.0) GO TO 31
```

```
      XPAR=(XGAMN-XSA)*SNALP
      IF (XPAR .LT. 0.0) GO TO 31
C
C     INTERPOLATE IN DATA TABLES FOR THE X-STATION XGAMN=X/RR.
C     GAMT=GAMMA/(2*PI*RLOC*VINF*SIN(ALFA))
C     YA1,YA2,ZA1 ARE DIVIDED BY RLOC.
C
      DO 20 J=1,NTABLE
      K=J
      IF (XPAR-XST(J)) 22,23,20
   20 CONTINUE
   23 GAMN     =GAMT(K)*SNALP
      ZGAMN    =ZA1(K)
      Y1=YA1(K)
      Y2=YA2(K)
      GO TO 30
   22 DELTA=(XPAR-XST(K-1))/(XST(K)-XST(K-1))
      GAMN     =GAMT(K-1) + DELTA*(GAMT(K)-GAMT(K-1))
      GAMN=GAMN*SNALP
      ZGAMN    =ZA1(K-1) + DELTA*(ZA1(K)-ZA1(K-1))
      Y1=YA1(K-1) + DELTA*(YA1(K)-YA1(K-1))
      Y2=YA2(K-1) + DELTA*(YA2(K)-YA2(K-1))
   30 YGAMN    =Y1
      IF (EMACH .GT. 1.0) YGAMN    =Y2
      GAMN=GAMN*F
      ZGAMN=ZGAMN*F
      GO TO 32
   31 GAMN=0.0
   32 CONTINUE
      IF (GAMN.NE.0.0) WRITE (6,702) XSA,GAMN,YGAMN,ZGAMN
      RETURN
      END
```

```
      SUBROUTINE BODYR(X,R,RPRIME)
C
C     VERSION: DEMON1
C
C SUBROUTINE FOR THE CALCULATION OF BODY RADII AND SLOPE.  THE INTEGER
C VARIABLE BCODE CONTROLS THE TYPE OF NOSE DEFINITION
C     BCODE=0   PARABOLIC BODY
C     BCODE=1   SEARS-HAACK-ADAMS BODY
C     BCODE=2   TANGENT OGIVE
C     BCODE=3   ELLIPSOIDAL BODY
C     BCODE=4   CONICAL BODY
C
      COMMON/TWO/DUM1(1214),BCODE,BETASQ,BSQ,RADIUS,RFIELD,DUM3 ,U,V,VT,
     1LNOSE,DUM2(5),LBODY,NXBODY
C
      REAL LNOSE,LBODY
      INTEGER BCODE
C
      IF(X.LE.LNOSE) GO TO 20
C
C CYLINDRICAL SECTION OF BODY
C
      R=RADIUS
      RPRIME=0.
      RETURN
C
C NOSE SECTION
```

```
C
   20 XX=(LNOSE-X)/LNOSE
      RR=RADIUS
      IF(BCODE.GT.0)GO TO 22
C
C PARABOLIC NOSE
C
      R=        RR*(1.-XX*XX)
      RPRIME=RR/LNOSE*2.*XX
      RETURN
   22 GO TO(23,24,25,26),BCODE
C
C SEARS-HAACK-ADAMS FOREBODY
C
   23 IF(XX.GT.9.999E-1) GO TO 223
      XY=1.-XX*XX
      PHI=XY**.75
      R=        RR*PHI
      RPRIME=RR/LNOSE*1.5*XX*PHI/XY
      RETURN
  223 R=0.0
      RPRIME=1.E9
      RETURN
C
C TANGENT OGIVE NOSE
C
   24 RL=RR/LNOSE
      RDL=.5*(1.+RL*RL)/RL
      XY=SQRT(RDL*RDL-XX*XX)
      R=RADIUS-LNOSE*(RDL-XY)
      RPRIME=XX/XY
      RETURN
C
C ELLIPSOID FOREBODY
C
   25 IF(XX.GT.9.999E-1) GO TO 223
      PHI=SQRT(1.-XX*XX)
      R=        RR*PHI
      RPRIME=RR/LNOSE*XX/PHI
      RETURN
C
C CONE FOREBODY
C
   26 R=        RR*(1.-XX)
      RPRIIME=RR/LNOSE
      RETURN
      END
```

```
      COMPLEX FUNCTION DBLU(Z)
C
C     VERSION: DEMON1
C
C     THIS FUNCTION SUBROUTINE CALCULATES THE INTERMEDIATE TRANSFORM
C     VARIABLE W FOR THE CONFORMAL TRANSFORMATION OF AN ELLIPTICAL
C     BODY WITH WINGS
C
      COMMON/COM1/A2,B2,R2
      COMMON/COM3/ZR,ZI
      COMMON/COM5/CWDZ
      COMMON/COM6/W2,W
```

```
C
      COMPLEX Z,Z2,DWDZ,W,W2,WW
C
      Z2=Z*Z
      ZR=REAL(Z)
      ZI=AIMAG(Z)
      IF(ZR.NE.0.0) ZR=ZR/ABS(ZR)
      IF(ZI.NE.0.0) ZI=ZI/ABS(ZI)
      Z2=Z2-A2+B2
      Y=AIMAG(Z2)
      AY=1.0
      IF(Y.LT.0.0) AY=-1.0
      AYZ=1.0
      IF(ZI.LT.0.0) AYZ=-1.0
      Z2=CSQRT(Z2)*AY*AYZ
      IF((ABS(ZI).LE.0.0).AND.(REAL(Z).LT.0.0)) Z2=CMPLX(-REAL(Z2),
     1     AIMAG(Z2))
      DWDZ=0.5*(1.0+Z/Z2)
      WW=0.5*(Z+Z2)
      W2=1.0/WW/WW
      DBLU=WW
      RETURN
      END
```

```
      SUBROUTINE DOUBLT(J)
C
C     VERSION: DEMON1
C
C SUBROUTINE TO CALCULATE THE VELOCITIES DUE TO A LINEAR LINE DOUBLET OF
C UNIT SLOPE WITH ORIGIN AT TX(J).
C
      INTEGER BCODE
      COMMON/TWO/TX(101),DUM1(505),ZZ(403),T(100),TC(100),COEFF(5),
     1BCODE,BETASQ,BSQ,RADIUS,RFIELD,RNOSE,U,V,VT,XA,XC,XD,BETA,XFIELD,
     2X2,XB,NXBODY
C
  100 FORMAT(1H0,59HFIELD POINT IS WITHIN TAIL MACH CONE.  U AND V SET T
     1O ZERO.)
C
C
C
C   IN THE FOLLOWING, U AND V SHOULD HAVE FACTOR COS(THPLPH) FACTOR IN
C     FRONT.
C                    VT SHOULD HAVE FACTOR SIN(THPLPH) FACTOR IN FRONT.
C   ANGLE THPLPH IS MEASURED CLOCKWISE FROM THE LEEWARD DIRECTION WHEN
C   VIEWED FROM THE REAR.
C   THE ANGULAR DEPENDENCE ON ANGLE THPLPH IS ACCOUNTED FOR IN
C   SUBROUTINE VELCAL.
      X1=XFIELD-TX(J)
      BR=BETA*RFIELD
      IF(X1.LE.BR     )GO TO 10
      IF(X2.LE.BR     )GO TO 21
      WRITE(6,100)
      GO TO 10
   21 XBR=X1/BR
      XX=SQRT(XBR*XBR-1.)
      U=BETA*XX
      ACOSH=ALOG(XBR+XX)
      YY=XBR*XX
```

```
      V=-.5*BETASQ*(ACOSH+XX)
      VT= .5*BETASQ*(ACOSH-XX)
      RETURN
C
C FIELD POINT IS AHEAD OF MACH CONE FROM DOUBLET ORIGIN.
C
   10 U=0.
      V=0.
      VT=0.
      RETURN
      END


      COMPLEX FUNCTION DSDZ(S)
C
C     VERSION: DEMON1
C
      COMMON/COM2/SIG2,W2
      COMMON/COM5/DWDZ
      COMMON/COM4/G2,G1
      COMMON/COM6/W2,W
      COMPLEX W,W2,DWDZ,G1,G2
      DSDZ=0.5*(1.0-SIG2*W2)*(1.0+G1/G2)*DWDZ
      RETURN
      END


      SUBROUTINE EDGES(MSWP,SPAN,RBOD,ANGLE,ANGTE,Y,SWLE,SWTE)
C
C     VERSION: DEMON1
C
C     THIS ROUTINE CALCULATES EQUALLY SPACED SIDE-EDGES.
C          SWEEP ANGLE ARRAYS ARE SET EQUAL TO CONSTANT
C          LEADING EDGE AND TRAILING EDGE VALUES.
C
      DIMENSION Y(1),SWLE(1),SWTE(1)
C
      DYR=SPAN/(MSWP-1)
      DO 50 I=1,MSWP
      AI=I-1
      SWLE(I)=ANGLE
      SWTE(I)=ANGTE
      Y(I)=DYR*AI+RBOD
   50 CONTINUE
      SWLE(1)=0.0
      SWTE(1)=0.0
C
      RETURN
      END


      SUBROUTINE EDGVOR
C
C     VERSION: DEMON1
C
C     COMPUTE EFFECTS AT CONTROL POINTS ON FINS AND BODY INTERFERENCE
C     SHELL OF FIN LEADING AND SIDE EDGE VORTICITY.
```

```
C
      LOGICAL BODY
C
      COMMON/ONE/CIRC(250),DELTP(250),FN(250),PNLC(250),SWPPLE(250),
     1SWPPTE(250),VNOR(250),XBAR(250),ZBAR(250),XCPT(250),YCPT(250),ZCPT
     2(250),XLF(250),XLB(250),XRF(250),XRB(250),YLC(250),YRC(250),ZLF(250
     30),ZRF(250),ZLB(250),ZRB(250),SNT(125),CST(125),SNT2(125),CST2(125
     4),IP(300),XFBIP(100),A,ALFA,ALFR,ARWING,B2,B2V,BETA,BETAR,CONST,
     5COSALF,COSBET,CN,DX,EM,FMACH,RCIR,SINALF,SINBET,SLOPE,TLRNC,TIPY,
     6TOTLR,U,V,W,UCHK,VCHK,WCHK,WBIP,X,Y,Z,I,IF,II,J,MSWR,MSWL,MSWU,
     7MSWD,NBIP,NCRX,NCW,NDRAG,NHP,NPR,NRP,NSP,NOCPT,NOLINP,NOUT,NPANLS,
     8NPRESS,NWBP,ASYM,BODY,DELTAS,NOSYM
      COMMON/VRTXV/VVRTX(150),WVRTX(150),NVRTPL,NVRTX,VRTMAX
      COMMON/BVEL/BDU(150),BDV(150),BDW(150),XFLDP(150),YFLDP(150),
     1 ZFLDP(150)
      COMMON/FINLE/XLE(80),CGLOC(80),GAMLE(80),FKLE,NEDGV,MLEVR,MLEVL,
     1 MLEVU,MLEVD
      COMMON/FINSE/XSE(80),CGSELC(80),GAMSE(80),FKSE,NSIDGE,NSEV
      COMMON/VORSPC/GAMMA(10),YVRTX(10),ZVRTX(10),PLOC
      COMMON/ELLIPS/RA,RB,ERATIO
C
      DATA PI/3.141592653589/
C
  716 FORMAT (1H1,15X,43HFIN L.E. AND S.E. EFFECTS AT CONTROL POINTS//
     1 2X,1HK,5X,4HX,CP,7X,4HY,CP,7X,4HZ,CP,6X,6HGAMMA/,6X,7HY,VRTX/,4X,
     2 7HZ,VRTX/,3X,6HV,VRTX,5X,6HW,VRTX/39X,11H2PI*RB*VINF,2X,2HRB,9X,
     3 2HRB/)
  717 FORMAT (1X,I3,8(1X,F10.5))
C
C
C     EFFECT OF FIN L.E. VORTICITY AT THE FIN CONTROL POINTS AND THE
C     BODY INTERFERENCE PANEL CONTROL POINTS.
C
      NOCPT=1
      NVRT=NVRTX
      IF (NOUT.NE.0) WRITE (6,716)
      JTIPLE=NRP-NCW+1
      XTIPLE=XRF(JTIPLE)
      DENOM=2.0*PI*RB
      JTIPTE=NRP
      XTIPTE=XRB(JTIPTE)
      DO 33 K=1,NWBP
      XFLDP(K)=XCPT(K)
      YFLDP(K)=YCPT(K)
      ZFLDP(K)=ZCPT(K)
      IF (NEDGV.EQ.0) GO TO 34
      IFIN=1
      KSTART=1
      KUL=MLEVR
   35 CONTINUE
      IF (IFIN.EQ.5) GO TO 34
      IF (IFIN.EQ.2) KSTART=MLEVR+1
      IF (IFIN.EQ.3) KSTART=MLEVR+MLEVL+1
      IF (IFIN.EQ.4) KSTART=MLEVR+MLEVL+MLEVU+1
      DO 36 IFV=KSTART,KUL
      IF (XCPT(K).LT.XLE(KSTART)) GO TO 34
      JV=IFV-1
      IF (IFV.EQ.1) JV=1
      IF (XCPT(K).LE.XLE(IFV)) GO TO 37
   36 CONTINUE
      IF (XCPT(K).LE.XTIPLE) GO TO 38
      GO TO 34
   37 KV=JV+1
```

```
      X1=XLE(JV)
      X2=XLE(KV)
      DIFF=X2-X1
      WT1=(X2-XCPT(K))/DIFF
      WT2=(XCPT(K)-X1)/DIFF
      IF (IFIN.EQ.3.OR.IFIN.EQ.4) GO TO 39
      YVINT=WT1*CGLOC(JV)+WT2*CGLOC(KV)
      ZVBAR=XCPT(K)*TAN(ALFR/2.0)
      GAMINT=WT1*GAMLE(JV)+WT2*GAMLE(KV)
      YVRTX(1)=YVINT/RB
      ZVRTX(1)=ZVBAR/RB
      GAMMA(1)=GAMINT/DENOM
      GO TO 31
   38 GAMMA(1)=GAMLE(KUL)/DENOM
      GAMINT=GAMLE(KUL)
      IF (IFIN.EQ.3.OR.IFIN.EQ.4) GO TO 32
      YVRTX(1)=CGLOC(KUL)/RB
      ZVRTX(1)=XCPT(K)*TAN(ALFR/2.0)/RB
      YVINT=CGLOC(KUL)
      ZVBAR=ZVRTX(1)*RB
      GO TO 31
   32 YVRTX(1)=-XCPT(K)*TAN(BETAR)/RB
      ZVRTX(1)=CGLOC(KUL)/RB
      YVINT=YVRTX(1)*RB
      ZVBAR=CGLOC(KUL)
   31 RLOC=RB
      NVRTX=1
      IF (BODY.AND.RA.EQ.RB) CALL VORTEX (K,K)
      YCP=YFLDP(K)
      ZCP=ZFLDP(K)
      THETP=ATAN2(ZCP,YCP)
      SINTH=SIN(THETP)
      COSTH=COS(THETP)
      RCPT=SQRT(YCP*YCP+ZCP*ZCP)
      RBODY=SQRT(1.0/((SINTH/RA)**2+(COSTH/RB)**2))
      IF (RCPT.LE.RBODY) GO TO 20
      GO TO 21
   20 YCP=1.01*RBODY*COSTH
      ZCP=1.01*RBODY*SINTH
   21 CONTINUE
      IF (BODY.AND.RA.NE.RB) CALL VVELS(1,YCP      ,ZCP      ,YVINT,ZVBAR,
     1 GAMINT,RB,RA,VVRTX(K),WVRTX(K),VRTMAX)
      IF (NOUT.NE.0) WRITE (6,717) K,XFLDP(K),YFLDP(K),ZFLDP(K),
     1 GAMMA(1),YVRTX(1),ZVRTX(1),VVRTX(K),WVRTX(K)
      GO TO 40
   39 ZVINT=WT1*CGLOC(JV)+WT2*CGLOC(KV)
      YVBAR=-XCPT(K)*TAN(BETAR/2.0)
      GAMINT=WT1*GAMLE(JV)+WT2*GAMLE(KV)
      YVRTX(1)=YVBAR/RB
      ZVRTX(1)=ZVINT/RB
      GAMMA(1)=GAMINT/DENOM
      RLOC=RB
      NVRTX=1
      IF (BODY.AND.RA.EQ.RB) CALL VORTEX (K,K)
      YCP=YFLDP(K)
      ZCP=ZFLDP(K)
      THETP=ATAN2(ZCP,YCP)
      SINTH=SIN(THETP)
      COSTH=COS(THETP)
      RCPT=SQRT(YCP*YCP+ZCP*ZCP)
      RBODY=SQRT(1.0/((SINTH/RA)**2+(COSTH/RB)**2))
      IF (RCPT.LE.RBODY) GO TO 22
      GO TO 23
```

```
22 YCP=1.01*RBODY*COSTH
   ZCP=1.01*RBODY*SINTH
23 CONTINUE
   IF (BODY.AND.RA.NE.RB) CALL VVELS(1,YCP      ,ZCP      ,YVBAR,ZVINT,
  1 GAMINT,RB,RA,YVRTX(K),ZVRTX(K),VRTMAX)
   IF (NOUT.NE.0) WRITE (6,717) K,XFLOP(K),YFLOP(K),ZFLOP(K),
  1 GAMMA(1),YVRTX(1),ZVRTX(1),YVRTX(K),ZVRTX(K)
40 CONTINUE
   IFIN=IFIN+1
   IF (IFIN.EQ.2) KUL=MLEVR+MLEVL
   IF (IFIN.EQ.3) KUL=MLEVR+MLEVL+MLEVU
   IF (NCPX.EQ.0) GO TO 34
   IF (IFIN.EQ.4) KUL=MLEVR+MLEVL+MLEVU+MLEVD
   GO TO 35
34 CONTINUE
C
C     EFFECTS OF FIN S.E. VORTICITY AT FIN CONTROL POINTS AND BODY
C     INTERFERENCE PANELS.
C
   IF (NSIDGE.EQ.0) GO TO 48
   IFIN=1
   KSTART=1
   KUL=NSEV
47 CONTINUE
   IF (IFIN.EQ.5) GO TO 48
   IF (IFIN.EQ.2) KSTART=NSEV+1
   IF (IFIN.EQ.3) KSTART=2*NSEV+1
   IF (IFIN.EQ.4) KSTART=3*NSEV+1
   DO 49 JSE=KSTART,KUL
   IF (XCPT(K).LT.XSE(KSTART)) GO TO 48
   JVSE=JSE-1
   IF (JSE.EQ.1) JVSE=1
   IF (XCPT(K).LE.XSE(JSE)) GO TO 46
49 CONTINUE
   IF (XCPT(K).LE.XTIPTE) GO TO 41
   GO TO 48
46 CONTINUE
   KVSE=JVSE+1
   X1=XSE(JVSE)
   X2=XSE(KVSE)
   DIFF=X2-X1
   WT1=(X2-XCPT(K))/DIFF
   WT2=(XCPT(K)-X1)/DIFF
   IF (IFIN.EQ.3.OR.IFIN.EQ.4) GO TO 45
   YVINT=WT1*CGSELC(JVSE)+WT2*CGSELC(KVSE)
   ZVBAR=XCPT(K)*TAN(ALFR/2.0)
   GAMINT=WT1*GAMSE(JVSE)+WT2*GAMSE(KVSE)
   YVRTX(1)=YVINT/RB
   ZVRTX(1)=ZVBAR/RB
   GAMMA(1)=GAMINT/DENOM
   GO TO 42
41 GAMMA(1)=GAMSE(KUL)/DENOM
   GAMINT=GAMSE(KUL)
   IF (IFIN.EQ.3.OR.IFIN.EQ.4) GO TO 43
   YVRTX(1)=CGSELC(KUL)/RB
   ZVRTX(1)=XCPT(K)*TAN(ALFR/2.0)/RB
   YVINT=CGSELC(KUL)
   ZVBAR=ZVRTX(1)*RB
   GO TO 42
43 YVRTX(1)=(-XCPT(K)*TAN(BETAR/2.0))/RB
   ZVRTX(1)=CGSELC(KUL)/RB
   YVINT=YVRTX(1)*RB
   ZVBAR=CGSELC(KUL)
```

```
   42 RLOC=RB
      NVRTX=1
      IF (BODY.AND.RA.EQ.RB) CALL VORTEX (K,K)
      IF (BODY.AND.RA.NE.RB) CALL VVELS(1,YFLDP(K),ZFLDP(K),YVINT,ZVBAR,
     1 GAMINT,RB,RA,VVRTX(K),WVRTX(K),VRTMAX)
      IF (NOUT.NE.0) WRITE (6,717) K,XFLDP(K),YFLDP(K),ZFLDP(K),
     1 GAMMA(1),YVRTX(1),ZVRTX(1),VVRTX(K),WVRTX(K)
      GO TO 44
   45 ZVINT=WT1*CGSELC(JVSE)+WT2*CGSELC(KVSE)
      YVBAR=-XCPT(K)*TAN(BETAR/2.0)
      GAMINT=WT1*GAMSE(JVSE)+WT2*GAMSE(KVSE)
      YVRTX(1)=YVBAR/RB
      ZVRTX(1)=ZVINT/RB
      GAMMA(1)=GAMINT/DENOM
      RLOC=RB
      NVRTX=1
      IF (BODY.AND.RA.EQ.RB) CALL VORTEX (K,K)
      IF (BODY.AND.RA.NE.RB) CALL VVELS(1,YFLDP(K),ZFLDP(K),YVBAR,ZVINT,
     1 GAMINT,RB,RA,VVRTX(K),WVRTX(K),VRTMAX)
      IF (NOUT.NE.0) WRITE (6,717) K,XFLDP(K),YFLDP(K),ZFLDP(K),
     1 GAMMA(1),YVRTX(1),ZVRTX(1),VVRTX(K),WVRTX(K)
   44 CONTINUE
      IFIN=IFIN+1
      IF (IFIN.EQ.2) KUL=2*NSEV
      IF (IFIN.EQ.3) KUL=3*NSEV
      IF (NCRX.EQ.0) GO TO 48
      IF (IFIN.EQ.4) KUL=4*NSEV
      GO TO 47
   48 CONTINUE
   33 CONTINUE
      NVRTX=NVRT
      RETURN
      END
```

```
      SUBROUTINE LAYOUT (SLPWLE,SLPWTE,Y,MSWP,CRP,NS,CTP,PHI,THET)
C
C     VERSION: DEMON2
C
C     THIS SUBROUTINE LAYS OUT AND DETERMINES GEOMETRICAL PROPERTIES
C     OF THE CONSTANT U-VELOCITY PANELS ON THE WING OR FIN SURFACES
C     AND ON THE BODY OR FUSELAGE WHERE MUTUAL WING-BODY INTERFERENCE
C     OCCURS.
C
      DIMENSION CSIDE(20),NPD(3),Y(1)
C
      LOGICAL LEFT,ASYM,BODY,DELTA,TRUSYM,NOSYM
C
      COMMON/ONE/CIRC(250),DELTP(250),FN(250),PNLC(250),SWPPLE(250),
     1SWPPTE(250),VNOR(250),XBAR(250),ZBAR(250),XCPT(250),YCPT(250),ZCPT
     2(250),XLF(250),XLB(250),XRF(250),XRB(250),YLC(250),YRC(250),ZLF(250
     30),ZRF(250),ZLB(250),ZRB(250),SNT(125),CST(125),SNT2(125),CST2(125
     4),IP(300),XFBIP(100),A,ALFA,ALFR,ARWING,B2,B2V,BETA,BETAR,CONST,
     5COSALF,COSBET,CN,DX,EM,FMACH,RCIR,SINALF,SINBET,SLOPE,TLRNC,TTPY,
     6TOTLR,U,V,W,UCHK,VCHK,WCHK,WBIP,X,DUMY,Z,IV,IF,II,JV,MSWR,MSWL,
     7MSWU,MSWD,NBIP,NCRX,NCW,NDRAG,NHP,NPR,NRP,N3P,NOCPT,NOLINP,NOUT,
     8NPANLS,NPRESS,NWBP,ASYM,BODY,DELTA,NOSYM
      COMMON/SWEEPS/VSWLER(20),VSWTER(20),VSWLEL(20),VSWTEL(20),
     1  VSWLEU(20),VSWTEU(20),VSWLED(20),VSWTED(20),LVSWP,LEFT,FAC,NCWB
     2,ARPNL(250),WIDTH(250)
```

```
      COMMON/VRTXV/DUMMY(301),NVRTX,VRTMAX
      COMMON/WBTR/THTI(125),XWLE
      COMMON /ELLIPS/ RA,RB,ERATIO
      COMMON /INTROT/ PHIDIH,THETIT,YBOD,ZBOD,PHIFR,PHIFU
C
C
      DATA PI/3.1415926535897/
C
C     FUNCTION DEFINING THE RADIUS OF AN ELLIPSE IN TERMS OF THT
C
      FRAD(SN,CS)=1.0/SQRT((CS/RB)**2+(SN/RA)**2)
      FYROT(YP) = COSINE*YP+YBOD
      FZROT(YP) = SINE  *YP+ZBOD
C
      TRUSYM=BETAR.EQ.0.0.AND..NOT.DELTA
      DTOR = PI/180.
C
C  NS(=IL+1) IS WING QUADRANT INDICATOR
C      NS=1, RIGHT FIN=  =2, LEFT FIN=  =3, UPPER FIN=  =4, LOWER FIN
C      NS=5, BODY
C     REFER TO MAIN PROGRAM CRFWBD FOR CORRESPONDENCE BETWEEN FINS ON
C     CRUCIFORM AND INTERDIGITATED CONFIGURATIONS.
C
      IF (NS.EQ.5) GO TO 200
      LEFT = NS.EQ.2 .OR. NS.EQ.4
      ANCW=NCW
      SLPDIF= SLPWLE-SLPWTE
      CSIDE(1)= CRP
      NPD(1)=NRP
      NPD(2)=NWP
      NPD(3)=N3P
C
C     VERTICAL WING TREATED IN THE SAME WAY AS HORIZONTAL WING
C     Y AND Z COORDINATES ARE INTERCHANGED FOR VERTICAL WING
C
C     LEFT STANDS FOR EITHER LEFT HORIZONTAL WING OR FOR LOWER
C     VERTICAL WING
C
C
C  LOCATE (Y,Z) OF WING BODY JUNCTION
C
      IF (THET.EQ.90.0) GO TO 100
      GO TO 101
  100 CS=0.0
      SN=1.0
      GO TO 104
  101 CONTINUE
      CS = COS(THET*DTOR)
      SN = SIN(THET*DTOR)
  104 CONTINUE
      RAD = FRAD(SN,CS)
      IF (LEFT) RAD=-RAD
      YBOD = RAD*CS
      ZBOD = RAD*SN
C
C        DEFINE DIHEDRAL ANGLES OF FINS
C
      IF (PHI.EQ.90.0) GO TO 102
      GO TO 103
  102 COSINE=0.0
      SINE=1.0
      GO TO 105
  103 CONTINUE
```

```
      COSINE = COS(PHI*DTOR)
      SINE   = SIN(PHI*DTOR)
  105 CONTINUE
C
C     INDEX I RUNS SPANWISE, K CHORDWISE ALONG WING
C     CALCULATE LENGTHS OF OUTBOARD PANEL SIDE,CSIDE
C     J IS THE PANEL NUMBER
C
      WLEX=0.0
      DO 140 I=2,NSWP
      IM=I-1
C
C     LVSWP: VARIABLE WING SWEEP OPTION
C        LVSWP=0,  GENERATE  Y  INTERNALLY(IN CREWBD)
C        LVSWP=1,  READ IN  Y*S.
C
      IF (LVSWP.EQ.0) GO TO 40
      GO TO (42,41,30,31),NS
C
C     CASE FOR YAWED WING, STREAMWISE PLANE PASSING THROUGH ROOTCHORD
C     LE INTERSECTS WING TE
C     TE SWEEPS MAY VARY AS A CONSEQUENCE
C
C     PANELS ON RIGHT HAND WING
C
   42 SLPWLE= TAN(VSWLER(I)*DTOR)
      SLPWTE= TAN(VSWTER(I)*DTOR)
      GO TO 44
C
C     PANELS ON LEFT HAND WING
C
   41 SLPWLE= TAN(-VSWLEL(I)*DTOR)
      SLPWTE= TAN(-VSWTEL(I)*DTOR)
      GO TO 44
C
C     PANELS ON UPPER WING
C
   30 SLPWLE=TAN(VSWLEU(I)*DTOR)
      SLPWTE=TAN(VSWTEU(I)*DTOR)
      GO TO 44
C
C     PANELS ON LOWER WING
C
   31 SLPWLE=TAN(-VSWLED(I)*DTOR)
      SLPWTE=TAN(-VSWTED(I)*DTOR)
C
C
   44 SLPDIF= SLPWLE-SLPWTE
      CSIDE(I)= CSIDE(IM)-(Y(I)-Y(IM))*SLPDIF
      IF (LEFT) CSIDE(I)=CSIDE(IM)+(Y(I)-Y(IM))*SLPDIF
      GO TO 43
C
C     NONVARYING L.E. AND T.E. SWEEPS  CONSTANT VALUES USED
C
   40 CSIDE(I)=CRP-(Y(I)-Y(1))*SLPDIF
      IF (LEFT) CSIDE(I)= CRP+(Y(I)-Y(1))*SLPDIF
   43 CONTINUE
C
C     SWPPLE AND SWPPTE ARE PANEL L.E. AND T.E. SWEEPS
C     CALCULATE PANEL CORNER POINT COORDINATES
C
      IF (I.EQ.2) GO TO 45
      JLE=(I-3)*NC+1
```

```
      IF (NS.GT.1) JLE=JLE+NPD(NS-1)
      WLEX=XRF(JLE)
      IF (LEFT) WLEX=XLF(JLE)
   45 CONTINUE
C
      DO 130 K=1,NCW
      J=(I-2)*NCW+K
      IF (NS.GT.1) J=J+NPD(NS-1)
      AKM=K-1
      AK=K
      SWPPLE(J)=SLPWLE-AKM*SLPDIF/ANCW
      SWPPTE(J)=SLPWLE-AK*SLPDIF/ANCW
      IF (ABS(SWPPLE(J)).LE.0.001) SWPPLE(J)=0.0
      IF (ABS(SWPPTE(J)).LE.0.001) SWPPTE(J)=0.0
      IF (LEFT) GO TO 50
C
C   PANEL LAY OUT FOR RIGHT RIGHT HAND WING CORNER POINYS.
C      THEY APPLY TO RIGHT AND UPPER FINS.
C
      XLF(J)=AKM*CSIDE(IM)/ANCW+WLEX
      XLB(J)=XLF(J)+CSIDE(IM)/ANCW
      XRF(J)=AKM*CSIDE(I)/ANCW+(Y(I)-Y(IM))*SLPWLE+WLEX
      XRB(J)=XRF(J)+CSIDE(I)/ANCW
      YLC(J)=Y(IM)
      YRC(J)=Y(I)
      GO TO 51
C
C   PANEL LAY OUT FOR LEFT HAND WING CORNER POINTS.
C      THEY APPLY TO LEFT AND LOWER FINS.
C
   50 CONTINUE
      XLF(J)=AKM*CSIDE(I)/ANCW-(Y(I)-Y(IM))*SLPWLE+WLEX
      XRF(J)=AKM*CSIDE(IM)/ANCW+WLEX
      XRB(J)= XRF(J)+CSIDE(IM)/ANCW
      XLB(J)= XLF(J)+CSIDE(I)/ANCW
      YLC(J)=Y(I)
      YRC(J)=Y(IM)
   51 CONTINUE
      ZLF(J)=0.0
      ZRF(J)=0.0
      ZLB(J)=0.0
      ZRB(J)=0.0
C
C      FIND Y-COORDINATE OF CONTROL POINT AND PANEL CENTROID
C
      A1=XRB(J)-XRF(J)
      A2=XLB(J)-XLF(J)
      H=Y(I)-Y(IM)
      YBAR=(2.0*A1+A2)*H/(3.0*(A1+A2))
      YCPT(J)=Y(IM)+YBAR
      IF (LEFT) YBAR=-(2.0*A2+A1)*H/(3.0*(A1+A2))
      IF (LEFT) YCPT(J)=Y(IM)-YBAR
C
C      FIND X-COORDINATE OF CONTROL POINT AND PANEL CENTROID
C
      XPCLE=XLF(J)+YBAR *SWPPLE(J)
      XPCTE=XLB(J)+YBAR*SWPPTE(J)
      IF (LEFT) XPCLE=XRF(J)+YBAR*SWPPLE(J)
      IF (LEFT) XPCTE=XRB(J)+YBAR*SWPPTE(J)
      PNLC(J)=XPCTE-XPCLE
      XCPT(J)=XPCLE+FAC *PNLC(J)
      XBAR(J)=(XPCTE+XPCLE)/2.0
C
```

```
C
      ZCPT(J)=0.0
      ZBAR(J)=0.0
      IF (.NOT.LEFT) GO TO 120
      IF (SWPPLE(J).EQ.0.0) SWPPLE(J)=TLRNC
      IF (SWPPTE(J).EQ.0.0) SWPPTE(J)=TLRNC
      SWPPLE(J)=-SWPPLE(J)
      SWPPTE(J)=-SWPPTE(J)
  120 CONTINUE
C
C         AREA AND WIDTH OF PANEL IN LOCAL COORDINATES
C
  121 ARPNL(J)=0.5*(YRC(J)-YLC(J))*(XLB(J)-XLF(J)+XRB(J)-XRF(J))
      WIDTH(J)=YRC(J)-YLC(J)
C
C     TRANSFORM FROM FIN COORDINATES TO THE WING REFERENCE COORDINATE
C     SYSTEM XW,YW,ZW.
C
      ZLF(J) = FZROT(YLC(J)-Y(1))
      ZLB(J) = ZLF(J)
      YLC(J) = FYROT(YLC(J)-Y(1))
      ZRF(J) = FZROT(YRC(J)-Y(1))
      ZRB(J) = ZRF(J)
      YRC(J) = FYROT(YRC(J)-Y(1))
      ZBAR(J) = FZROT(YCPT(J)-Y(1))
      ZCPT(J) = ZBAR(J)
      YCPT(J) = FYROT(YCPT(J)-Y(1))
  130 CONTINUE
  140 CONTINUE
      CTP=CSIDE(MSWP)
      RETURN
C
C     ************* LAY OUT BODY INTERFERENCE PANELS *******************
C
  200 DX=CRP/NCWB
C
C
C    NOTE: MSWP IS ACTUALLY NBDCR
C
     MSWP = 4*(MSWP/4)
     MS90  = MSWP/4
     MS180 = 2*MS90
     MS270 = 3*MS90
     MMSWP = MSWP
     IF (TRUSYM) MMSWP=MMSWP/2
     DTHTDG = 90./FLOAT(MS90)
     DTHTS = DTHTDG
     DTHTU = DTHTDG
C
C    IT1IT2,IT3,IT4....INDEX OF INTERFERENCE PANEL IMMEDIATELY
C    PRECEDING FIN LOCATIONS ON BODY CIRCUMFERENCE.
C
C    INITIALIZE
     IT1 = 0
     IT2 = 0
     IT3 = 0
     IT4 = 0
     IF (THETIT.GE.90. .OR. THETIT.LE.0.) GO TO 210
C
C INTERDIGITATED TAIL EXISTS
C
C
C    RECALCULATE RADIUS AT AND YB,ZB COORDINATES OF FIN LOCATION
```

```
C     ON THE BODY CIRCUMFERENCE FOR THE RIGHT UPPER FIN ONLY.
C
      CS=COS(THETIT*DTOR)
      SN=SIN(THETIT*DTOR)
      RAD=FRAD(SN,CS)
      YBOD=RAD*CS
      ZBOD=RAD*SN
C
C     CHECK RATIO OF APPROXIMATE ARC LENGTH ON EITHER SIDE OF THETIT.
C
C
      ARCU=SQRT(YBOD**2+(ZBOD-RA)**2)
      ARCS=SQRT((RB-YBOD)**2+ZBOD**2)
      DARC=(ARCU+ARCS)/FLOAT(MS90)
C
C     DETERMINE NUMBER OF PANELS BETWEEN Y-AXIS AND FIN LOCATION ON THE
C     BODY CIRCUMFERENCE.
C
      IT1= IFIX((ARCS/DARC)+0.5)
      IT1= MAX0(IT1,1)
      IT1=MIN0(IT1,MS90-1)
C
C        DTHTS IS INCREMENT BETWEEN PANELS ON RIGHT AND LEFT (0-THETIT)
C        DTHTU IS INCREMENT BETWEEN PANELS ON TOP AND BOTTOM (THETIT-90)
C
      DTHTS = THETIT/IT1
      DTHTU = (90.-THETIT)/(MS90-IT1)
      IT2 = MS180-IT1
      IT3 = MS180+IT1
      IT4 = MSWP-IT1
210   CONTINUE
C
C     HERE K HAS ONE VALUE FOR EACH RING OF BIP*S
C     FOR EACH CIRCUMFERENTIAL RING, THE X FRONT POSITION, XFBIP(L)
C     IS A CONSTANT --
C     XFBIP(L) IS THE X-STATION OF THE BODY RING IN WING COORDINATES
C
  201 KX=0
      DO 230 K=1,NBIP,MMSWP
      XS=KX*DX
      KP=K+MMSWP-1
C
C        L IS BODY PANEL INDEX
C
      DO 220 L=K,KP
      XFBIP(L)=XS
220   CONTINUE
      KX=KX+1
230   CONTINUE
C
C     CALCULATE THE TRIG FUNCTIONS OF THE ANGLES ASSOCIATED WITH EACH
C     BIP.  THIS LOOP EXECUTES ONCE FOR EACH DIFFERENT BIP ORIENTATION,
C     SETS THE FUNCTIONS FOR ALL BIP*S THAT ARE AT THE SAME ANGLE.
C
C     ANG IS THE ANGLE OF ROTATION OF THE BIP WITH RESPECT TO THE WING
C     COORDINATE SYSTEM.
C     THT IS THE POLAR ANGLE OF THE BIP WITH RESPECT TO THE WING Y-AXIS.
C
C
C BODY PANEL NUMBERING BEGINS AT Z=0, Y=RB AND PROCEEDS
C COUNTERCLOCKWISE IN ANGLE , THEN INCREMENTED IN X.
C
      IK = 0
```

```
      THTIDG = 0.0
      YIM1 = RB
      ZIM1 = 0.0
C
C     I IS THE RUNNING INDEX ON THE BODY CIRCUMFERENCE.
      DO 260 I=1,MSWP
C
C   GENERATE ANGLE TO BE INCREMENTED BETWEEN TAIL SEGMENTS
C
      DTHT = DTHTS
C
C        TEST FOR UPPER OR LOWER BODY PANEL WIDTH
C
      IF (I.GT.IT1 .AND. I.LE.IT2) DTHT=DTHTU
      IF (I.GT.IT3 .AND. I.LE.IT4) DTHT=DTHTU
      THTIDG = THTIDG+DTHT
      IF (I.EQ.MS90)  THTIDG=90.
      IF (I.EQ.MS180) THTIDG=180.
      IF (I.EQ.MS270) THTIDG=270.
      IF (I.EQ.MSWP)  THTIDG=360.
C
C   COMPUTE GEOMETRY OF ELLIPTIC BODY AND PRESCRIBED ANGLE.
C
      THT=THTIDG*DTOR
C
C     COMPUTE PROPERTIES OF ELLIPTIC BODY
C     RAD IS THE LOCAL BODY RADIUS AS A FUNCTION OF THT
C     THT IS THE MERIDIAN ANGLE FOR THE PANEL MEASURED COUNTERCLOCKWISE
C     FROM THE Y(WING) AXIS
C
      SN=SIN(THT)
      CS=COS(THT)
      YI=FRAD(SN,CS)*CS
      ZI=FRAD(SN,CS)*SN
C
C  CHECK FOR BODY SYMMETRY
C
      IF (I.GT.MS90 .AND. I.LE.MS270 .AND. TRUSYM) GO TO 250
      IK = IK+1
      DY=YI-YIM1
      DZ=ZI-ZIM1
      WBIP=SQRT(DZ*DZ+DY*DY)
      SN2= DZ/WBIP
      CS2=-DY/WBIP
      AREAP=WBIP*DX
C
C        J IS THE PANEL INDEX OF BIPS
C        K IS THE PANEL INDEX OF WING AND BODY PANELS
C
      DO 240 J=IK,NBIP,MMSWP
      K=J+NPANLS
      THTI(J)=THTIDG
      SNT(J)=SN
      CST(J)=CS
      SNT2(J)=SN2
      CST2(J)=CS2
C
C
      YCPT(K)=0.5*(YI+YIM1)
      ZCPT(K)=0.5*(ZI+ZIM1)
C
      SWPPLE(K)=0.0
      SWPPTE(K)=0.0
```

```
      ARPNL(K)=AREAP
C
C     NOTE -- IN THE **BIP** SYSTEM, YLC=0 AND YRC=WBIP
C
C     DEFINE BIP PANEL CORNER POINTS IN  WING COORDINATE SYSTEM
C
      YLC(K)=YI
      YRC(K)=YIM1
      ZLF(K)=ZI
      ZLB(K)=ZI
      ZRF(K)=ZIM1
      ZRB(K)=ZIM1
      XLF(K)=XFBIP(J)
      XRF(K)=XLF(K)
      XLB(K)=XLF(K)+DX
      XRB(K)=XLB(K)
C
C     CONTROL POINT X COORDINATE IN WING SYSTEM
C
240   XCPT(K)=XFBIP(J)+FAC*DX
250   CONTINUE
      YIM1=YI
      ZIM1=ZI
  260 CONTINUE
      RETURN
      END


      SUBROUTINE LINEQS(N,A)
C
C     VERSION: DEMON1
C
C     THIS SUBROUTINE TAKES IN SINGLE COLUMN MATRIX A(N*N), CONVERTS IT
C     TO SQUARE MATRIX A(N*N) AND
C     IP(300) REMEMBERS WHAT WAS DONE TO TRIANGULATE MATRIX A
C      IT IS USED IN SOLVE TO DO SAME THING TO B
C
      DIMENSION A(N,N)
C
      LOGICAL ASYM,BODY,DELTA,NOSYM
C
      COMMON/ONE/DUM1(6000),IP(300),DUM2(100),DUM3(54),ASYM,BODY,DELTA,
     1NOSYM
C
      IP(N)=1
      DO 6 K=1,N
      IF(K.EQ.N)GO TO 5
      KP1=K+1
      M=K
      IP(K)=M
      IF(M.NE.K)IP(N)=-IP(N)
      T=A(M,K)
      A(M,K)=A(K,K)
      A(K,K)=T
      IF(T.EQ.0.)GO TO 5
      DO 2 I=KP1,N
    2 A(I,K)=-A(I,K)/T
      DO 4 J=KP1,N
      T=A(M,J)
      A(M,J)=A(K,J)
      A(K,J)=T
      IF(T.EQ.0.)GO TO 4
      DO 3 I=KP1,N
    3 A(I,J)=A(I,J)+A(I,K)*T
```

```
    4 CONTINUE
    5 IF(A(K,K).EQ.0.)IP(N)=0
    6 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE LOADS
C
C     VERSION:DEMON2.
C
C     THIS SUBROUTINE CALCULATES FORCES AND MOMENTS ACTING ON THE
C     WINGS OR FINS AND THE INTERFERENCE SHELL.
C     THEY ARE FIRST CALCULATED IN THE WING REFERENCE COORDINATE SYSTEM
C     AND THEN TRANSFORMED TO WIND-AXIS SYSTEM.
C
C     IN-PLANE FORCES FX AND FY1 OR FZ1 ARE ALSO COMPUTED. HERE,FX
C     IS POSITIVE FORWARD PARALLEL TO BODY CENTERLINE.
C     IN-PLANE FORCE FY2 IS CALCULATED IN SUBROUTINE SPNLD.
C
      DIMENSION BFY(100),BFZ(100)
      DIMENSION XB(150),YC(150),ZB(150)
C
      LOGICAL ASYM,NOSYM,BODY,DELTA,ANY,ANYMO
C
      COMMON/ONE/CIRC(250),DELTP(250),FN(250),PNLC(250),SWPPLE(250),
     1SWPPTE(250),VNOR(250),XBAR(250),ZBAR(250),XCPT(250),YCPT(250),ZCPT
     2(250),XLF(250),XLB(250),XRF(250),XRB(250),YLC(250),YRC(250),ZLF(250
     30),ZRF(250),ZLB(250),ZRB(250),SNT(125),CST(125),SNT2(125),CST2(125
     4),IP(300),XFBIP(100),A,ALFA,ALFR,ARWING,B2,B2V,BETA,BETAR,CONST,
     5COSALF,COSBET,CN,DX,EM,FMACH,RCIR,SINALF,SINBET,SLOPE,TLRNC,TIPY,
     6TOTLR,U,V,W ,UCHK,VCHK,WCHK,WBIP,X,Y,Z,IV,IF,II,JV,MSWR,MSWL,MSWU,
     7MSWD,NBIP,NCRX,NCW,NDRAG,NHP,NPR,NRP,NSP,NOCPT,NOLINP,NOUT,NPANLS,
     8NPRESS,NWBP,ASYM,BODY,DELTA,NOSYM
      COMMON/THREE/ANGLR,ANGLL,ANGLU,ANGLD,DELR,DELL,DELU,DELD,SREF,REFL
      COMMON/SWEEPS/VSWLER(20),VSWTER(20),VSWLEL(20),VSWTEL(20),
     1  VSWLEU(20),VSWTEU(20),VSWLED(20),VSWTED(20),LVSWP,LEFT,FAC,NCWB
     2,ARPNL(250),WIDTH(250)
      COMMON/BVEL/BDU(150),BDV(150),BDW(150),XFLDP(150),YFLDP(150),
     1 ZFLDP(150)
      COMMON/SPCPRS/DLTP(150)
      COMMON/VRTXV/VVRTX(150),WVRTX(150),NVRTPL,NVRTX,VRTMAX
      COMMON/WBTR/THTI(125),XWLE
      COMMON/FRCDIS/VNOROS(150),FX(150),FY(150),FZ(150),DLTPG(150),ANYMO
      COMMON/VRTHVL/VVEL(500),WVEL(500),JCPT,NCPOUT,NVLIN
      COMMON/SPSANG/SINALC,COSALC,SINPHI,COSPHI
      COMMON /ELLIPS/ RA,RB,ERATIO
      COMMON/INTRDT/PHIDTH,THETIT,YBOD,ZBOD,PHIFR,PHIFU
      COMMON/DAFM/XM,ZM,CZOA,CYOA,CMOA,CLNOA,CLLOA
C
      DATA PI/3.141592653590/
C
C
  701 FORMAT(1H1,25X,21HWING PANEL PROPERTIES,//,2X,1HJ,5X,7HYCPT(J),3X,
     1 10HCHORD THRU,4X,5HPANEL,3X,8HMIDCHORD,9X,6HDELTA=,5X,5HFN(J),/
     2 18X,8HCENTROID,6X,4HSPAN,4X,10HSWEEP,DEG.,7X,2HCP,//)
  702 FORMAT(////25X,21HWING PANEL PROPERTIES,//2X,1HJ,5X,7HZCPT(J),3X,
     1 10HCHORD THRU,4X,5HPANEL,3X,8HMIDCHORD,9X,6HDELTA=,5X,5HFN(J),/
     2 18X,8HCENTROID,6X,4HSPAN,4X,10HSWEEP,DEG.7X,2HCP,//)
  705 FORMAT (8X,I3,7X,F10.5,2X,F10.5,2X,F10.5,2X,F10.5,2X,F10.5,
     12X,F10.5,2X,F10.5)
  706 FORMAT (1X,I3,2(1X,F10.5),5(2X,F10.5))
```

```
707 FORMAT(1H1,20X,31HBODY INFLUENCE PANEL PROPERTIES//2X,1HJ,6X,
   1  7HYCPT(J),4X,6HLENGTH,6X,5HWIDTH,6X,8HTHETA(J),2X,5HFY(J),5X,
   2  5HFZ(J),5X,5HFN(J),5X,8HDELTA-CP,3X,7HGAMMA/V/)
710 FORMAT (1X,I3,9(1X,F10.5))
716 FORMAT(1H1,25X,35HVELOCITIES AT PANEL CENTROID POINTS//
   1  10X,1HJ,11X,7HXBAR(J),5X,7HYBAR(J),5X,7HZBAR(J),9X,1HU,11X,
   2  1HV,11X,1HW,8X,4HVNOR//)
717 FORMAT(1H1,40X,19HLOADING INFORMATION//
   X  11X,14HMACH NUMBER = ,E12.5/
   1  7X,18HANGLE OF ATTACK = ,F8.3,1X,7HDEGREES/
   27X,18HSIDE SLIP ANGLE = ,F8.3,1X,7HDEGREES/
   3 13X,12HWING AREA = ,F10.5/
   4 8X,17HREFERENCE AREA = ,F10.5/
   5 6X,19HREFERENCE LENGTH = ,F10.5/
   6 3X,22HEXPOSED WING SPAN B = ,F10.5/
   7 3X,22HMOMENT CENTER:   XM = ,F10.5/
   8    20X,5HZM = ,F10.5///)
718 FORMAT(/29X,5HTOTAL,12X,10HFIN 1 OR R,8X,10HFIN 2 OR L,7X,
   1 10HFIN 3 OR U,8X,10HFIN 4 OR D,5X,13HINTERF. SHELL,/
   2  6X,19HDEFL. ANGLE DEG. = ,12X,4(6X,F12.5)/
   * 18X,7HCTHR = ,E12.5,4(6X,E12.5)/
   3  20X,5HCZ = ,E12.5,5(6X,E12.5)/
   4   20X,5HCY = ,E12.5,5(6X,E12.5)/
   5 20X,5HCM = ,E12.5,5(6X,E12.5)/
   5 19X,6HCLN = ,E12.5,5(6X,E12.5)/
   7 19X,6HCLL = ,E12.5,5(6X,E12.5)/
   * //,20X,33HFOLLOWING ARE IN WIND-AXIS SYSTEM//
   8   20X,5HCL = ,E12.5,5(6X,E12.5)/
   * 16X,9HCYWIND = ,E12.5,5(6X,E12.5)/
   9   19X,6HCDI = ,E12.5,5(6X,E12.5)/
   1   13X,12HCDI/CL**2 = ,E12.5/
   * 16X,9HCMWIND = ,E12.5,5(6X,E12.5)/
   * 15X,10HCLNWIND = ,E12.5,5(6X,E12.5)////)
725 FORMAT (//1X,28HU/VINF TYPE LOADING PRESSURE//)
726 FORMAT (//1X,32HBERNOULLI TYPE LOADING PRESSURE//)
727 FORMAT(1H1,27X,40HVELOCITIES AT PANEL OUTBOARD AFT CORNERS/)
728 FORMAT(1H0,9X,1HJ,11X,6HXRB(J),6X,6HYRC(J),6X,6HZRB(J),10X,1HU,
   1   11X,1HV,11X,1HW,8X,4HVNOR//)
729 FORMAT(1H0,9X,1HJ,11X,6HXLB(J),6X,6HYLC(J),6X,6HZLB(J),10X,1HU,
   1   11X,1HV,11X,1HW,8X,4HVNOR//)
730 FORMAT (///10X,61HNOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW
   1IS SUPERSONIC/)
C
C
C
C
C
C
C     CALCULATE WING AND BODY PANEL INDUCED VELOCITIES AT THE CENTROID
C     POINTS AND OUTBOARD AFT CORNER OF FIN CONSTANT U-VELOCITY PANELS
C     ALSO ADD VELOCITIES DUE TO FIXED VORTICES AND/OR MOVING VORTICES.
C
C
C     IF BODY HAS ELLIPTICAL CROSS SECTION, USE BDU,BDV,BDW CAL-
C     CULATED AT FIN CONTROL POINTS.
C
      IF (NDRAG.EQ.0) GO TO 513
      NOCPT=1
      II=1
      IF=NWBP
      IF(NOUT.EQ.1) WRITE (6,716)
      DO 508 J=1,NPANLS
      XFLDP(J)=XBAR(J)
      YFLDP(J)=YCPT(J)
```

```
  508 ZFLDP(J)=ZCPT(J)
      NSTART=1
      IF (BODY.AND.RA.EQ.RB) CALL VELCAL(NPANLS,ALFR,BETAR,NSTART)
      DO 510 J=1,NPANLS
      CALL VELNOR(XBAR(J),YCPT(J),ZBAR(J))
      UCT=UCHK
      VCT=VCHK
      WCT=WCHK
      IF(J.GT.NHP) GO TO 509
      VNOR(J)=WCHK+BDW(J)+WVEL(J)+WVRTX(J)
      GO TO 512
  509 VNOR(J)=VCHK+BDV(J)+VVEL(J)+VVRTX(J)
  512 CONTINUE
      IF (NOUT.NE.1) GO TO 510
      WRITE (6,705) J,XBAR(J),YCPT(J),ZBAR(J),UCT,VCT,WCT,VNOR(J)
  510 CONTINUE
C
C     HERE    N=1.....RIGHT HOR. FIN
C             N=2.....LEFT  HOR. FIN
C             N=3.....UPPER VERT. FIN
C             N=4.....LOWER VERT. FIN
C
      IF(NOUT.EQ.1) WRITE (6,727)
      N=0
      JSTART=1
      JTIP=NRP-NCW+1
      TIPCHD=XRB(NRP)-XRF(JTIP)
      JEND=NRP
  607 N=N+1
      IF (NOUT.EQ.1.AND.(N.EQ.1.OR.N.EQ.3)) GO TO 911
      IF (NOUT.EQ.1) WRITE (6,729)
      GO TO 912
  911 WRITE (6,728)
  912 DO 608 J=JSTART,JEND
      IF(N.EQ.2.OR.N.EQ.4) GO TO 908
      XFLDP(J)=XRB(J)
      YFLDP(J)=YRC(J)
      ZFLDP(J)=ZRB(J)
      XB(J)=XRB(J)
      YC(J)=YRC(J)
      ZB(J)=ZRB(J)
C
C     FOR WINGS WITH SIDE EDGES:
C     IF L.E. SWEEP OF CHORDWISE ROW NEAREST THE TIP IS SUBSONIC,
C     MOVE THE OUTBOARD CORNER OUT ONE PANEL WIDTH
C
      IF (TIPCHD.LT.100.0*TLRNC) GO TO 608
      IF (N.EQ.1.AND.J.GE.JTIP.AND.SWPPLE(JTIP).GT.BETA) GO TO 909
      IF (N.EQ.3.AND.J.GE.JTIP.AND.SWPPLE(JTIP).GT.BETA) GO TO 925
      GO TO 608
  909 YC(J)=YRC(J)+1.0*WIDTH(J)
      GO TO 608
  925 ZB(J)=ZRB(J)+1.0*WIDTH(J)
      GO TO 608
  908 XFLDP(J)=XLB(J)
      YFLDP(J)=YLC(J)
      ZFLDP(J)=ZLB(J)
      XB(J)=XLB(J)
      YC(J)=YLC(J)
      ZB(J)=ZLB(J)
      IF (TIPCHD.LT.100.0*TLRNC) GO TO 608
      IF (N.EQ.2.AND.J.GE.JTIP.AND.ABS(SWPPLE(JTIP)).GT.BETA) GO TO 924
      IF (N.EQ.4.AND.J.GE.JTIP.AND.ABS(SWPPLE(JTIP)).GT.BETA) GO TO 926
```

```
      GO TO 608
  924 YC(J)=YLC(J)-1.0*WIDTH(J)
      GO TO 608
  926 ZB(J)=ZRB(J)-1.0*WIDTH(J)
  608 CONTINUE
      IF (BODY.AND.RA.EQ.PR) CALL VELCAL(JEND,ALFR,BETAR,JSTART)
      DO 610 J=JSTART,JEND
      CALL VELNOR(XB(J),YC(J),ZB(J))
      UCT=UCHK
      VCT=VCHK
      WCT=WCHK
      IF (J.GT.NHP) GO TO 915
      VNOROS(J)=WCHK+BDW(J)+WVEL(J)+WVRTX(J)
      GO TO 913
  915 VNOROS(J)=VCHK+BDV(J)+VVEL(J)+VVRTX(J)
  913 IF(NOUT.NE.1) GO TO 610
      WRITE (6,705) J,XB(J),YC(J),ZB(J),UCT,VCT,WCT,VNOROS(J)
  610 CONTINUE
      IF (.NOT.NOSYM) GO TO 513
      IF (N.NE.1) GO TO 611
      JSTART=NRP+1
      JEND=NHP
      JTIP=NHP-NCW+1
      TIPCHD=XLR(NHP)-XLF(JTIP)
      GO TO 607
  611 IF (N.NE.2.OR.NHP.EQ.NPANLS) GO TO 612
      JSTART=NHP+1
      JEND=N3P
      JTIP=N3P-NCW+1
      TIPCHD=XRR(N3P)-XRF(JTIP)
      GO TO 607
  612 IF (N.NE.3) GO TO 513
      JSTART=N3P+1
      JEND=NPANLS
      JTIP=NPANLS-NCW+1
      TIPCHD=XLR(NPANLS)-XLF(JTIP)
      GO TO 607
  513 CONTINUE
C
C
C
C     INITIALIZE VARIABLES
C
      CNB=0.
      CYB=0.
      CZBIP=0.0
      CYBIP=0.0
      CMBIP=0.0
      CLNBIP=0.0
      CLLBIP=0.0
      CLBIP=0.0
      CDIBIP=0.0
      CYWBIP=0.0
      CMBIPW=0.0
      CLNBPW=0.0
C
C        ENTER HERE FOR NONLINEAR PRESSURE LOADINGS
C
      ENTRY SPECLD
C
      DTOR=PI/180.0
      AREA=0.0
      CZOA=0.0
```

```
      CYOA=0.0
      CMOA=0.0
      CLNOA=0.0
      CLLOA=0.0
      CZFINU=0.0
      CZFIND=0.0
      CYFINU=0.0
      CYFIND=0.0
      CMFINU=0.0
      CMFIND=0.0
      CLNFU=0.0
      CLNFD=0.0
      CLLFU=0.0
      CLLFD=0.0
      CYU=0.
      CYD=0.
      CTHRU=0.
      CTHRD=0.
      CTHRR=0.0
      CTHRL=0.0
      CLR=0.0
      CLL=0.0
      CLU=0.0
      CLD=0.0
      CDIR=0.0
      CDIL=0.0
      CDIU=0.
      CDID=0.
      CDCLS=0.0
      CYWR=0.0
      CYWL=0.0
      CYWU=0.0
      CYWD=0.0
      CMFRW=0.
      CMFLW=0.
      CMFUW=0.
      CMFDW=0.
      CLNFRW=0.0
      CLNFLW=0.0
      CLNFUW=0.0
      CLNFDW=0.0
      CNADDV=0.0
      CYADDH=0.0
C
      BETAY= BETAR/DTOR
      ANY=NOSYM
      ANYMOS=.NOT.ASYM
C
C     PUT MOMENT CENTER IN WING COORDINATE SYSTEM.
C
      XMW=XM-XWLE
C
C
C     NOTE:  DLTPG IS DELTA-LOADING PRESSURE/Q  OR DELTA-CP
C
      DO 902 I=1,NPANLS
      IF (NPRESS.EQ.0) DLTPG(I)=DELTP(I)
      IF (NPRESS.EQ.1) DLTPG(I)=DLTP(I)
  902 CONTINUE
C
C
C
C     WRITE OUT BTP PANEL PROPERTIES
```

```
C     CONTRIBUTION FROM BODY INTERFERENCE PANELS TO CZ...CNB
C     CONTRIBUTION FROM BODY INTERFERENCE PANELS TO CY...CYB
C
      IF(NBIP.EQ.0) GO TO 160
      IF (NPRESS.NE.0) GO TO 161
      IF (NOUT.NE.0) WRITE (6,707)
      DO 140 K=1,NBIP
      I=K+NPANLS
      F=DELTP(I)*ARPNL(I)
      FN(I)=F
      CALL ROTBW(0.,F,BFY(K),BFZ(K),K)
      CNB=CNB+BFZ(K)
      L=I
      CYB=CYB+BFY(K)
      CIRC(L)=0.5*DELTP(I)*DX
      ARM=XCPT(I)-XM
      BFZM=-BFZ(K)*ARM
      CMBIP=CMBIP+BFZM
      BFYM=-BFY(K)*ARM
      CLNBIP=CLNBIP+BFYM
      BIPRM=-BFZ(K)*YCPT(L)+BFY(K)*(ZCPT(L)-ZM)
      CLLBIP=CLLBIP+BIPRM
      IF (NOUT.NE.0)
     1WRITE(6,710) L,YCPT(L),DX,WBIP,THTI(K),BFY(K),BFZ(K),FN(L),
     1DELTP(L),CIRC(L)
  140 CONTINUE
      CZBIP=CNB/SREF
      CYBIP=CYB/SREF
      CMBIP=CMBIP/(SREF*REFL)
      CLNBIP=CLNBIP/(SREF*REFL)
      CLLBIP=CLLBIP/(SREF*REFL)
      IF (ANY) GO TO 161
      CZBIP=2.0*CZBIP
      CYBIP=0.0
      CMBIP=2.0*CMBIP
      CLNBIP=0.0
      CLLBIP=0.0
  161 CONTINUE
  160 CONTINUE
C
C
C
C     CALCULATE FORCES,CZFIN,CYFIN, ACTING ON THE FINS,
C     PITCHING MOMENT,CMFIN,YAWING MOMENT,CLNF,ROLLIN MOMENT,CLLF.
C     CTHR IS THRUST FORCE. LAST LETTER DESIGNATES FIN AS FOLLOWS.
C        R.....HOR. RIGHT FIN
C        L.....HOR. LEFT FIN
C        U.....VERT. UPPER FIN
C        D.....VERT. LOWER FIN
C     BIP......INTERFERENCE SHELL.
C
C     ALSO:
C     IN WING OR BODY COORDINATE SYSTEM,
C     FX.....THRUST FORCE IN NEG. X-DIR. IN PLANE OF WING/O
C     FY.....SIDE FORCE IN Y-DIRECTION IN PLANE OF WING/O
C     FZ.....UPWARDS FORCE IN Z-DIR. IN PLANE OF VERTICAL WING
C  NOTE:  ADDITIONAL CONTRIBUTIONS TO IN PLANE FORCES ARE CALCULATED
C     IN SUBROUTINE SPNLD.
C     PRESENTLY, IN-PLANE FORCES  SUITABLE FOR CRUCIFORM OR PLANAR
C     FINS OR WINGS ONLY.
C
C     THE 300 LOOP IS USED FOR THE RIGHT AND LEFT HORIZONTAL PANELS
C
```

```
      IF (NOUT .NE.0) WRITE (6,701)
      JL=1
      JU=NRP
      IL=0
      ANGL=ANGLR
      SINANG=SIN(ANGL)
      PHIF=PHIFR*DTOR
  302 CONTINUE
      CZFIN=0.0
      CYFIN=0.0
      CMFIN=0.0
      CLNFIN=0.0
      CLLFIN=0.0
      CNN=0.0
      CTHP=0.0
      DO 300 J=JL,JU
      AREA=AREA+ARPNL(J)
      I=J
      F=    ARPNL(J)*DLTPG(I)
      FN(I)=F
      YCHK= YCPT(I)*COSBET-XBAR(I)*SINBET
      IF (ANYMO) YCHK=YCPT(I)
      ARM=XCPT(J)-XMW
      CALL ROTFW(0.0,F,CYP,CZP,PHIF)
      CMP=-CZP*ARM
      CLNP=-CYP*ARM
      PRM=-CZP*YCPT(J)+CYP*(ZCPT(J)-ZM)
      CZFIN=CZFIN+CZP
      CYFIN=CYFIN+CYP
      CMFIN=CMFIN+CMP
      CLNFIN=CLNFIN+CLNP
      CLLFIN=CLLFIN+PRM
      CNN=CNN+F
C
C     CIRC IS GAMMA/V (FT),BASED ON LINEAR PRESSURE.
C
      CIRC(J)=0.5*DLTPG(J)*PNLC(J)
      SLPMC=0.5*(SWPPLE(J)+SWPPTE(J))
      SWPMC=ATAN(SLPMC)*57.2957795
      IF (NDRAG.EQ.0) GO TO 299
      FX(J)=2.*WIDTH(J)*CIRC(J)*(SINANG+VNOR(J))
      FY(J)=FX(J)*SLPMC
      CYADDH=CYADDH+FY(J)
      CTHR=CTHR+FX(J)
  299 IF (NOUT.NE.0)
     1WRITE (6,706) J,YCPT(J),PNLC(J),WIDTH(J),SWPMC,DLTPG(J),FN(J)
  300 CONTINUE
C
      IF (IL.EQ.1) GO TO 310
      CNR=CNN/SREF
      CZFINR=CZFIN/SREF
      CYFINR=CYFIN/SREF
      CMFINR=CMFIN/(SREF*REFL)
      CLNFR=CLNFIN/(SREF*REFL)
      CLLFR=CLLFIN/(SREF*REFL)
      CTHRR=CTHR/SREF
C
C  NOTE: SYMMETRY CONSIDERATIONS ARE USED IN DIFFERENT MANNER FOR
C     THE CASE OF INTERDIGITATED TAIL FINS (THETIT.NE.0).
C     REFER TO MAIN PROGRAM CRFWBD FOR DESIGNATIONS OF INTERDIGITATED
C     FINS.
C
      IF(ANY) GO TO 301
```

```
      AREA=2.0*AREA
      IF (THETIT.NE.0.0) GO TO 303
      GO TO 304
  303 CZFIND=CZFINR
      CYFIND=-CYFINR
      CMFIND=CMFINR
      CLNFD=-CLNFR
      CLLFD=-CLLFR
      CTHRD=CTHRR
      CYD=CNR
      GO TO 311
  304 CZFINL=CZFINR
      CYFINL=-CYFINR
      CMFINL=CMFINR
      CLNFL=-CLNFR
      CLLFL=-CLLFR
      CTHRL=CTHRR
      CNL = CNR
      CYADDH=0.0
      GO TO 311
  301 CONTINUE
C
C     REENTER ABOVE LOOP FOR LEFT HORIZONTAL PANEL
C
      IL=1
      JL=JU+1
      JU=NHP
      ANGL=ANGLL
      SINANG=SIN(ANGL)
      GO TO 302
  310 CZFINL=CZFIN/SREF
      CYFINL=CYFIN/SREF
      CMFINL=CMFIN/(SREF*REFL)
      CLNFL=CLNFIN/(SREF*REFL)
      CLLFL=CLLFIN/(SREF*REFL)
      CTHRL=CTHR/SREF
      CNL=CNN/SREF
  311 CONTINUE
      IF(NHP.EQ.NPANLS) GO TO 350
C
C     THE 320 LOOP IS USED FOR THE UPPER AND LOWER VERTICAL PANELS
C
      IF (NOUT .NE.0) WRITE (6,702)
      JL=NHP+1
      JU=N3P
      IL=0
      ANGL=ANGLU
      SINANG=SIN(ANGL)
      PHIF=PHIFU*DTOR
  325 CONTINUE
      CZFIN=0.0
      CYFIN=0.0
      CMFIN=0.0
      CLNFIN=0.0
      CLLFIN=0.0
      CYY=0.0
      CTHR=0.0
      DO 320 J=JL,JU
      I=J
      F=     ARPNL(J)*DLTPG(I)
      FN(I)=F
      ZCHK= ZCPT(I)*COSALF+XBAR(I)*SINALF
      IF (ANYMO) ZCHK=ZCPT(I)
```

```
      ARM=XCPT(J)-XMW
      CALL ROTFN(0.0,F,CYP,CZP,PHIF)
      CMP=-CZP*ARM
      CLNP=-CYP*ARM
      PRM=-CZP*YCPT(J)+CYP*(ZCPT(J)-ZM)
      CZFIN=CZFIN+CZP
      CYFIN=CYFIN+CYP
      CMFIN=CMFIN+CMP
      CLNFIN=CLNFIN+CLNP
      CLLFIN=CLLFIN+PRM
      CYY=CYY-F
      CIRC(J)=0.5*DLTPG(J)*PNLC(J)
      SLPMC=0.5*(SWPPLE(J)+SWPPTE(J))
      SWPMC=ATAN(SLPMC)*57.2957795
      IF (NDRAG.EQ.0) GO TO 319
      FX(J)=2.*WIDTH(J)*CIRC(J)*(SINANG-VNOR(J))
      FZ(J)=FX(J)*SLPMC
      CNADDV=CNADDV+FZ(J)
      CTHR=CTHR+FX(J)
  319 IF (NOUT.NE.0)
     1WRITE (6,706) J,ZCPT(J),PNLC(J),WIDTH(J),SWPMC,DLTPG(J),FN(J)
  320 CONTINUE
      IF (IL.EQ.1) GO TO 330
      CZFINU=CZFIN/SREF
      CYFINU=CYFIN/SREF
      CMFINU=CMFIN/(SREF*REFL)
      CLNFU=CLNFIN/(SREF*REFL)
      CLLFU=CLLFIN/(SREF*REFL)
      CTHRU=CTHR/SREF
      CYU=CYY/SREF
      IF(ANY) GO TO 321
      IF (THETIT.NE.0.0) GO TO 322
      GO TO 350
  322 CZFINL=CZFINU
      CYFINL=-CYFINU
      CMFINL=CMFINU
      CLNFL=-CLNFU
      CLLFL=-CLLFU
      CTHRL=CTHRU
      CNL=CYU
      GO TO 350
  321 CONTINUE
C
C     REENTER ABOVE LOOP FOR LOWER VERTICAL PANEL
C
      IL=1
      JL=JU+1
      JU=NPANLS
      ANGL=ANGLD
      SINANG=SIN(ANGL)
      GO TO 325
  330 CZFIND=CZFIN/SREF
      CYFIND=CYFIN/SREF
      CMFIND=CMFIN/(SREF*REFL)
      CLNFD=CLNFIN/(SREF*REFL)
      CLLFD=CLLFIN/(SREF*REFL)
      CTHRD=CTHR/SREF
      CYD=CYY/SREF
  350 CONTINUE
C
C
C
C
```

```
C
C     OVERALL FORCE AND MOMENTT COEFFICIENTS FOR FINS AND INTERFERENCE
C     SHELL IN WING OR BODY REFERNCE SYSTEM.
C
C     CTHROA.....ACTS ALONG NEGATIVE X-AXIS
C     CYOA.......ACTS ALONG POSITIVE Y-AXIS
C     CZOA.......ACTS ALONG POSITIVE Z-AXIS
C     CMOA.......VECTOR ALONG NEGATIVE Y-AXIS,NOSE UP POS.
C     CLNOA......VECTOR ALONG POSITIVE Z-AXIS,NOSE TO RIGHT POS.
C     CLLNOA.....VECTOR ALONG POSITIVE X-AXIS, RIGHT WING DOWN POS.
C
C     CNADDV,CYADDH...ADDITIONS TO CZOA,CYOA DUE TO IN PLANE FORCES,NOT
C     SUCTION CONVERSION TO NORMAL FORCE.
C
C     FORCE COEFFICIENTS IN X,Y,Z DIRECTIONS.
C
      CTHROA=CTHRR+CTHRL+CTHRU+CTHRD
      CZOA=CZFINR+CZFINL+CZFINU+CZFIND+CZBIP
      CYOA=CYFINR+CYFINL+CYFINU+CYFIND+CYBIP
      CNADDV=CNADDV/SREF
      CYADDH=CYADDH/SREF
C
C     PITCHING,YAWING,ROLLING MOMENTS COEFFICIENTS.
C
      CMOA=CMFINR+CMFINL+CMFINU+CMFIND+CMBIP
      CLNOA=CLNFR+CLNFL+CLNFU+CLNFD+CLNBIP
      CLLOA=CLLFR+CLLFL+CLLFU+CLLFD+CLLBIP
C
C
C     OVERALL FORCE AND MOMENT COEFFICIENTS IN WIND-AXIS SYSTEM(EXCEPT
C     ROLLING MOMENT)
C
C     CDI.....ACTS BACK ALONG FREE STREAM DIRECTION,XWIND-AXIS
C     CYW.....ACTS TO THE RIGHT NORMAL TO FREE STREAM VECTOR-BODY
C             CENTER LINE PLANE,YWIND-AXIS
C     CL......ACTS UPWARDS IN FREE STREAM VECTOR-BODY CENTERLINE
C             PLANE NORMAL TO FREE STREAM VECTOR,ZWIND-AXIS
C     CMOAW...VECTOR ALONG NEGATIVE YWIND-AXIS,NOSE UP POS.
C     CLNOAW..VECTOR ALONG POSITIVE ZWIND-AXIS,NOSE TO RIGHT,POS.
C
C     DRAG,LATERAL,LIFT FORCE COEFFICIENTS
C
      CDIR=-CTHRR*COSALC-CYFINR*SINALC*SINPHI+CZFINR*SINALC*COSPHI
      CDIL=-CTHRL*COSALC-CYFINL*SINALC*SINPHI+CZFINL*SINALC*COSPHI
      CDIU=-CTHRU*COSALC-CYFINU*SINALC*SINPHI+CZFINU*SINALC*COSPHI
      CDID=-CTHRD*COSALC-CYFIND*SINALC*SINPHI+CZFIND*SINALC*COSPHI
      CDIBIP=              -CYBIP*SINALC*SINPHI+CZBIP*SINALC*COSPHI
      CDI=CDIR+CDIL+CDIU+CDID+CDIBIP
C
C
      CYWR=CZFINR*SINPHI+CYFINR*COSPHI
      CYWL=CZFINL*SINPHI+CYFINL*COSPHI
      CYWU=CZFINU*SINPHI+CYFINU*COSPHI
      CYWD=CZFIND*SINPHI+CYFIND*COSPHI
      CYWBIP=CZBIP*SINPHI+CYBIP*COSPHI
      CYW=CYWR+CYWL+CYWU+CYWD+CYWBIP
C
C
      CLR=CTHRR*SINALC-CYFINR*COSALC*SINPHI+CZFINR*COSALC*COSPHI
      CLL=CTHRL*SINALC-CYFINL*COSALC*SINPHI+CZFINL*COSALC*COSPHI
```

```
      CLU=CTHRU*SINALC-CYFINU*COSALC*SINPHI+CZFINU*COSALC*COSPHI
      CLD=CTHRD*SINALC-CYFIND*COSALC*SINPHI+CZFIND*COSALC*COSPHI
      CLBIP=            -CYBIP*COSALC*SINPHI+CZBIP*COSALC*COSPHI
      CL=CLR+CLL+CLU+CLD+CLBIP
      CDCLS=CDI/(CL*CL)
C
C     PITCHING,YAWING MOMENTS
C
      CMFRW=CMFINR*COSPHI-CLNFR*SINPHI
      CMFLW=CMFINL*COSPHI-CLNFL*SINPHI
      CMFUW=CMFINU*COSPHI-CLNFU*SINPHI
      CMFDW=CMFIND*COSPHI-CLNFD*SINPHI
      CMBIPW=CMBIP*COSPHI-CLNBIP*SINPHI
      CMOAW=CMFRW+CMFLW+CMFUW+CMFDW+CMBIPW
C
C
      CLNFRW=-CLLFR*SINALC+CMFINR*COSALC*SINPHI+CLNFR*COSALC*COSPHI
      CLNFLW=-CLLFL*SINALC+CMFINL*COSALC*SINPHI+CLNFL*COSALC*COSPHI
      CLNFUW=-CLLFU*SINALC+CMFINU*COSALC*SINPHI+CLNFU*COSALC*COSPHI
      CLNFDW=-CLLFD*SINALC+CMFIND*COSALC*SINPHI+CLNFD*COSALC*COSPHI
      CLNBPW=-CLLBIP*SINALC+CMBIP*COSALC*SINPHI+CLNBIP*COSALC*COSPHI
      CLNOAW=CLNFRW+CLNFLW+CLNFUW+CLNFDW+CLNBPW
C
C
C     WRITE ALL LOADING RESULTS.
C
      SPAN=2.0*B2
      WRITE(6,717) FMACH,ALFA,BETAY,AREA,SREF,REFL,SPAN,XM,ZM
      IF (NPRESS.EQ.0) WRITE (6,725)
      IF (NPRESS.EQ.1) WRITE (6,726)
      WRITE (6,718) DELR,DELL,DELU,DELD,
     1 CTHROA,CTHRR,CTHRL,CTHRU,CTHRD,
     2 CZOA,CZFINR,CZFINL,CZFINU,CZFIND,CZBIP,
     3 CYOA,CYFINR,CYFINL,CYFINU,CYFIND,CYBIP,
     4 CMOA,CMFINR,CMFINL,CMFINU,CMFIND,CMBIP,
     5 CLNOA,CLNFR,CLNFL,CLNFU,CLNFD,CLNBIP,
     6 CLLOA,CLLFR,CLLFL,CLLFU,CLLFD,CLLBIP,
     7 CL,CLR,CLL,CLU,CLD,CLBIP,
     * CYW,CYWR,CYWL,CYWU,CYWD,CYWBIP,
     8 CDI,CDIR,CDIL,CDIU,CDID,CDIBIP,
     9 CDCLS,
     *CMOAW,CMFRW,CMFLW,CMFUW,CMFDW,CMBIPW,
     *CLNOAW,CLNFRW,CLNFLW,CLNFUW,CLNFDW,CLNBPW
C
C     CHECK ON SUPERSONIC L.E. BASED ON L.E. SWEEP OF INBOARD
C     CHORDWISE ROW
C
      ARGTAN=1.0/BETA
      ANGMCH=(ATAN(ARGTAN))*57.2957795
      PSIMCH=90.0-ANGMCH
      PSIPLE=(ATAN(SWPPLE(1)))*57.2957795
      IF (PSIMCH.GT.PSIPLE) WRITE(6,730)
C
C
C
C
      IF (THETIT.NE.0.0) RETURN
      CALL SPNLD
      RETURN
      END
```

```
      SUBROUTINE OUT(A,N)
C
C     VERSION: DEMON1
C
      DIMENSION A(N,N)
    1 FORMAT(10(1X,E11.4))
    2 FORMAT (1H )
      DO 100 I=1,N
      WRITE (6,1) (A(I,J),J=1,N)
  100 WRITE(6,2)
      RETURN
      END
```

```
      SUBROUTINE ROTATE(YIN,ZIN,YOUT,ZOUT,PHIF)
C
C     VERSION:DEMON2.
C
C     THIS SUBROUTINE ROTATES LOCAL  COORDINATES RELATIVE TO CONSTANT
C     U-VELOCICITY PANEL CORNERS AND PARALLEL TO WING COORDINATE
C     SYSTEM TO LOCAL COORDINATES IN THE PLANE OF THE PANEL ITSELF AND
C     VICE VERSA.
C
      COMMON/ONE/DUM1(6400),A,DUM2(5),BETA,DUM3(6),EM,DUM4(4),SLOPE,
     1TLRNC,TIPY,TOTLR,U,V,W,DUM5(4),X,YS,ZS,MI,DUM6(2),MJ,DUM7(8),NHP,
     2NPR,DUM8(2),NOCPT,NULINP,NOUT,NPANLS,DUM9(2),ASYM,BODY,DELTA,NOSYM
      COMMON/INTROT/PHIDIH,THETIT,YBOD,ZBOD,PHIFR,PHIFU
C
      DATA PIO2/1.570796326795/
C
C
C     WING TO FIN
C
      ENTRY ROTWF
      IF (ABS(PHIF-PIO2).LT.TLRNC) GO TO 100
      GO TO 101
  100 COSPHI=0.0
      SINPHI=1.0
      GO TO 104
  101 CONTINUE
      COSPHI=COS(PHIF)
      SINPHI=SIN(PHIF)
  104 CONTINUE
      YOUT=YIN*COSPHI+ZIN*SINPHI
      ZOUT=ZIN*COSPHI-YIN*SINPHI
      RETURN
C
C     FIN TO WING
C
      ENTRY ROTFW
      IF (ABS(PHIF-PIO2).LT.TLRNC) GO TO 102
      GO TO 103
  102 COSPHI=0.0
      SINPHI=1.0
      GO TO 105
  103 CONTINUE
      COSPHI=COS(PHIF)
      SINPHI=SIN(PHIF)
  105 CONTINUE
      YOUT=YIN*COSPHI-ZIN*SINPHI
      ZOUT=ZIN*COSPHI+YIN*SINPHI
      RETURN
      END
```

```
      SUBROUTINE SOLVE (B,A,N)
C
C     VERSION: DEMON1
C
C
C     THIS SUBROUTINE TAKES IN THE TRIANGULATED MATRIX A, RIGHT HAND
C     SIDE VECTOR B, IT IS OPERATED ON BY IP(300)
C     SOLUTION THEN PROCEEDS, ANSWER IS IN VECTOR B AGAIN
C
      DIMENSION B(1)
      DIMENSION A(N,N)
C
      LOGICAL ASYM,BODY,DELTA,NOSYM
C
      COMMON/ONE/DUM1(6000),IP(300),DUM2(102),ALFR,DUM3(18),TOTLR,
     1DUM4(21),NDRAG,DUM5(4),NOCPT,NOLINP,NOUT,NPANLS,NPRESS,NWBP,ASYM,
     2BODY,DELTA,NOSYM
C
C
      IF(N.EQ.1)GO TO 9
      NM1=N-1
      DO 7 K=1,NM1
      KP1=K+1
      M=IP(K)
      T=B(M)
      B(M)=B(K)
      B(K)=T
      DO 7 I=KP1,N
    7 B(I)=B(I)+A(I,K)*T
C
C
      DO 8 KB=1,NM1
      KM1=N-KB
      K=KM1+1
      B(K)=B(K)/A(K,K)
      T=-B(K)
      IF (T.EQ.0.0) GO TO 9
      DO 8 I=1,KM1
    8 B(I)=B(I)+A(I,K)*T
    9 B(1)=B(1)/A(1,1)
      RETURN
      END
```

```
      SUBROUTINE SOURCE(J)
C     VERSION: DEMON
C
C     VERSION: DEMON1
C
C SUBROUTINE TO CALCULATE THE VELOCITIES DUE TO A LINEAR LINE SOURCE OF
C UNIT SLOPE WITH ORIGIN AT TX(J).
C SOLUTIONS GIVEN BY WOODWARD AND LARSEN (BOING REPT. D6-10741),EQUATION
C (53) OR ANTONIO FERRI, "ELEMENTS OF AERODYNAMICS OF SUPERSONIC FLOWS,"
C EQUATION (378).
C
      INTEGER BCODE
      COMMON/TWO/TX(101),DUM1(1113),BCODE,BETASQ,BSQ,RADIUS,RFIELD,RNOSE
     1,U,V,VT,XA,XC,XD,BETA,XFIELD,X2,XB,NXBODY
C
C
  100 FORMAT(1H0,59HFIELD POINT IS WITHIN TAIL MACH CONE,  U AND V SET TO
```

```
     10 ZERO,)
C
      X1=XFIELD-TX(J)
      BR=BETA*RFIELD
      IF(X1.LE.BR) GO TO 10
      IF(X2.LE.BR)GO TO 11
      WRITE(6,100)
      GO TO 10
   11 XL=X1/BR
      D23= SQRT(XL*XL-1.)
      U=-ALOG(XL+D23)
      V=BETA*D23
      RETURN
C
C FIELD POINT IS AHEAD OF MACH CONE FROM SOURCE ORIGIN.
C
   10 U=0.
      V=0.
      RETURN
      END


      SUBROUTINE SPECPR
C
C     VERSION: DEMON1
C
C     THIS SUBROUTINE COMPUTES BERNOULLI PRESSURES AT CONTROL POINTS
C     OF THE CONSTANT U-VELOCITY PANELS
C     ON THE WING OR FIN SURFACES
C
C
C
      DIMENSION PRESSA(150),PRESSB(150),PRESSR(150),PRESSL(150)
C
      LOGICAL BODY,ASYM,DELTA,NOSYM
C
      COMMON/ONE/DUM1(250),DELTP(250),DUM2(1750),XCPT(250),YCPT(250),
     1ZCPT(250),DUM3(3402),ALFR,ARWING,DUM4(2),BETA,BETAR,CONST,COSALF,
     2COSBET,CN,DX,EM,FMACH,RCIR,
     2                              SINALF,SINBET,DUM5(3),TOTLR,DUM6(3),UCHK,
     3VCHK,WCHK,DUM7(4),I,IF,II,K,DUM8(4),NBIP,NCRX,NCW,NDRAG,NHP,NPR,
     4NRP,N3P,NOCPT,NOLINP,NOUT,NPANLS,NPRESS,NWBP,ASYM,BODY,DELTA,NOSYM
      COMMON/BVEL/BDU(150),BDV(150),BDW(150),XFLDP(150),YFLDP(150),
     1 ZFLDP(150)
      COMMON/SPCPRS/DLTP(150)
      COMMON/SPSANG/SINALC,COSALC,SINPHI,COSPHI
      COMMON/VRTXV/VVRTX(150),WVRTX(150),NVRTPL,NVRTX,VRTMAX
      COMMON/THKDAT/NTDAT,NCWT,NTPR,MSWT(4),NRPT,NHPT,N3PT,NTHP,ASYMT,
     1       NVERT,SWLET(20,4),SWTET(20,4),YTH(20,4),THETAL(400)
      COMMON/ICVEL/UTCHK,VTCHK,WTCHK,IIT,IFT,MJ
      COMMON/VPTHVL/VVEL(500),WVEL(500),JCPT,NCPOUT,NVLIN
      COMMON /ELLIPS/ RA,RB,ERATIO
C
C
C
  720 FORMAT(1X,I3,11F11.6)
  721 FORMAT (1X,I3,6F11.6,11X,3F11.6)
  732 FORMAT(////10X,104HVELOCITIES AND BERNOULLI PRESSURES AT CONTROL P
     1OINTS IMMEDIATELY ABOVE AND BELOW HORIZONTAL WING SURFACE//
     22X,1HJ,6X,4HX(J),7X,4HY(J),7X,4HZ(J),5X,5HUTOTA,6X,5HVTOTA,
     36X,5HWTOTA,6X,6HPRESSA,5X,5HUTOTB,6X,5HVTOTB,6X,5HWTOTB,
     46X,6HPRESSB/)
```

```
  734 FORMAT(////10X,107HVELOCITIES AND BERNOULLI PRESSURES AT CONTROL P
     1OINTS IMMEDIATELY TO RIGHT AND LEFT OF VERTICAL WING SURFACE//
     22X,1HJ,6X,4HX(J),7X,4HY(J),7X,4HZ(J),5X,5HUTOTR,6X,5HVTOTR,
     36X,5HWTOTR,6X,6HPRESSR,5X,5HUTOTL,6X,5HVTOTL,6X,5HWTOTL,6X,
     46HPRESSL/)
  736 FORMAT (////3X,35HPRESSURE LOADINGS AT CONTROL POINTS//
     1 2X,1HJ,7X,4HX(J),7X,4HY(J),7X,4HZ(J),4X,10HDELTP.LIN.,1X,
     2   11HDELTP,BERN,/)
  737 FORMAT (1H1,77HPRESSURE LOADINGS EXCLUDE VORTEX INDUCED COMPONENTS
     1 PARALLEL TO WING SURFACES//)
  738 FORMAT (1H1,77HPRESSURE LOADINGS INCLUDE VORTEX INDUCED COMPONENTS
     1 PARALLEL TO WING SURFACES//)
C
C
      NOCPT=1
      NHP1=NHP+1
      NPNLS1=NPANLS+1
      IF (NVRTX.NE.0.AND.NVRTPL.EQ.0) WRITE (6,737)
      IF (NVRTX.NE.0.AND.NVRTPL.EQ.1) WRITE (6,738)
C
C
C     POINTS IMMEDIATELY ABOVE AND BELOW WING SURFACE TREATED
C     SEPARATELY DUE TO DISCONTINUITY IN INFLUENCE FUNCTIONS
C     WHEN Z EQUALS ZERO.
C
C
      WRITE (6,732)
C
C
C
C     WING SURFACES AND BODY INTERFERENCE PANELS CONTRIBUTION
C
      FACTR1=1.428571429/(FMACH*FMACH)
      FACTR2=0.2*FMACH*FMACH
C
      DO 805 J=1,NHP
      XFLDP(J)=XCPT(J)
      YFLDP(J)=YCPT(J)
  805 ZFLDP(J)=ZCPT(J)
      NSTART=1
      IF (BODY.AND.RA.EQ.RB) CALL VELCAL(NHP,ALFR,BETAR,NSTART)
      DO 807 K=1,NHP
      VADVRT=VVRTX(K)
      IF (NVRTX.NE.0.AND.NVRTPL.EQ.0) VADVRT=0.0
C
C     DISCONTINOUS CONTRIBUTION
C     ADD IN CONTRIBUTIONS FROM EXTERNAL VORTICES.
C
      II=K
      IF=K
      CALL VELNOR(XCPT(K),YCPT(K),ZCPT(K))
C
C     A...ABOVE          B...BELOW
C
      UTOTA=UCHK+BDU(K)
      VTOTA=VCHK+BDV(K)+VADVRT+VVEL(K)
      WTOTA=      BDW(K)+WVRTX(K)+WVEL(K)
C
      UTOTB=-UCHK+BDU(K)
      VTOTB=-VCHK+BDV(K)+VADVRT+VVEL(K)
      WTOTB=      BDW(K)+WVRTX(K)+WVEL(K)
      IF (NOUT.NE.0)
     1WRITE (6,721) K,XCPT(K),YCPT(K),ZCPT(K),UTOTA,VTOTA,WTOTA,UTOTB,
```

```
     1 VTOTB,WTOTB
C
C      CONTINOUS CONTRIBUTION FROM HORIZONTAL FINS
C
      II=1
      IF=NHP
      CALL VELNOR(XCPT(K),YCPT(K),ZCPT(K))
      WTOTA=WTOTA+WCHK
      WTOTB=WTOTB+WCHK
      IF (NOUT.NE.0)
     1WRITE (6,721) K,XCPT(K),YCPT(K),ZCPT(K),UTOTA,VTOTA,WTOTA,UTOTB,
     1 VTOTB,WTOTB
      IF (NHP.EQ.NWBP) GO TO 801
C
C      CONTRIBUTION FROM VERTICAL FINS AND BODY INTERFERENCE PANELS.
C
      II=NHP1
      IF=NWBP
      CALL VELNOR(XCPT(K),YCPT(K),ZCPT(K))
      UTOTA=UTOTA+UCHK
      VTOTA=VTOTA+VCHK
      WTOTA=WTOTA+WCHK
C
      UTOTB=UTOTB+UCHK
      VTOTB=VTOTB+VCHK
      WTOTB=WTOTB+WCHK
      IF (NOUT.NE.0)
     1WRITE (6,721) K,XCPT(K),YCPT(K),ZCPT(K),UTOTA,VTOTA,WTOTA,UTOTB,
     1 VTOTB,WTOTB
  801 CONTINUE
C
C      SOURCE PANEL CONTRIBUTION
C
      IF(NTDAT.EQ.0) GO TO 830
      III=1
      IFT=NTHP
      MJ=K
      CALL THKVEL(XCPT(K),YCPT(K),ZCPT(K))
      UTOTA=UTOTA+UTCHK
      VTOTA=VTOTA+VTCHK
      WTOTA=WTOTA+WTCHK
      UTOTB=UTOTB+UTCHK
      VTOTB=VTOTB+VTCHK
      WTOTB=WTOTB-WTCHK
      IF (NOUT.NE.0)
     1WRITE (6,721) K,XCPT(K),YCPT(K),ZCPT(K),UTOTA,VTOTA,WTOTA,UTOTB,
     1 VTOTB,WTOTB
  830 CONTINUE
C
      BDUSQ=UTOTA*UTOTA
      BDVSQ=VTOTA*VTOTA
      BDWSQ=WTOTA*WTOTA
      UBAR=UTOTA*COSALC-VTOTA*SINBET+WTOTA*SINALF
      ARG=1.0-FACTR2*(2.0*UBAR+BDUSQ+BDVSQ+BDWSQ)
      PRESSA(K)=-FACTR1
      IF(ARG.GE.TOTLR)PRESSA(K)=FACTR1*(ARG**3.5-1.0)
      BDUSQ=UTOTB*UTOTB
      BDVSQ=VTOTB*VTOTB
      BDWSQ=WTOTB*WTOTB
      UBAR=UTOTB*COSALC-VTOTB*SINBET+WTOTB*SINALF
      ARG=1.0-FACTR2*(2.0*UBAR+BDUSQ+BDVSQ+BDWSQ)
      PRESSB(K)=-FACTR1
      IF(ARG.GE.TOTLR)PRESSB(K)=FACTR1*(ARG**3.5-1.0)
```

```
      WRITE(6,720)K,XCPT(K),YCPT(K),ZCPT(K),UTOTA,VTOTA,WTOTA,
     1     PRESSA(K),UTOTB,VTOTB,WTOTB,PRESSB(K)
  807 CONTINUE
C
C     POINTS IMMEDIATELY TO THE RIGHT AND THE LEFT OF VERTICAL
C     WING SURFACE TREATED SEPARATELY DUE TO DISCONTINUITY IN
C     INFLUENCE FUNCTIONS WHEN Y EQUALS ZERO.
C     ADD IN CONTRIBUTIONS FROM EXTERNAL VORTICES.
C
C
      IF (NCRX.EQ.0) GO TO 841
      WRITE (6,734)
C
C
      DO 808 J=NHP1,NPANLS
      XFLOP(J)=XCPT(J)
      YFLOP(J)=YCPT(J)
  808 ZFLOP(J)=ZCPT(J)
      NSTART=NHP1
C
      IF (BODY.AND.RA.EQ.RB) CALL VELCAL(NPANLS,ALFR,BETAR,NSTART)
      DO 813 K=NHP1,NPANLS
      WADVRT=WVRTX(K)
      IF (NVRTX.NE.0.AND.NVRTPL.EQ.0) WADVRT=0.0
C
      II=K
      IF=K
      CALL VELNOR(XCPT(K),YCPT(K),ZCPT(K))
      UTOTR=UCHK+BDU(K)
      VTOTR=       BDV(K)+VVRTX(K)+VVEL(K)
      WTOTR=WCHK+BDW(K)+WADVRT+WVEL(K)
      UTOTL=UCHK+BDU(K)
      VTOTL=       BDV(K)+VVRTX(K)+VVEL(K)
      WTOTL=WCHK+BDW(K)+WADVRT+WVEL(K)
      IF (NOUT.NE.0)
     1WRITE (6,721) K,XCPT(K),YCPT(K),ZCPT(K),UTOTR,VTOTR,WTOTR,UTOTL,
     1  VTOTL,WTOTL
C
      II=NHP1
      IF=NPANLS
      CALL VELNOR(XCPT(K),YCPT(K),ZCPT(K))
      VTOTR=VTOTR+VCHK
      VTOTL=VTOTL+VCHK
      IF (NOUT.NE.0)
     1WRITE (6,721) K,XCPT(K),YCPT(K),ZCPT(K),UTOTR,VTOTR,WTOTR,UTOTL,
     1  VTOTL,WTOTL
C
      II=1
      IF=NHP
      CALL VELNOR(XCPT(K),YCPT(K),ZCPT(K))
      UTOTR=UTOTR+UCHK
      VTOTR=VTOTR+VCHK
      WTOTR=WTOTR+WCHK
      UTOTL=UTOTL+UCHK
      VTOTL=VTOTL+VCHK
      WTOTL=WTOTL+WCHK
      IF (NOUT.NE.0)
     1WRITE (6,721) K,XCPT(K),YCPT(K),ZCPT(K),UTOTR,VTOTR,WTOTR,UTOTL,
     1  VTOTL,WTOTL
C
      IF (NPANLS.EQ.NWBP) GO TO 803
      II=NPNLS1
      IF=NWBP
      CALL VELNOR(XCPT(K),YCPT(K),ZCPT(K))
```

```
      UTOTR=UTOTR+UCHK
      VTOTR=VTOTR+VCHK
      WTOTR=WTOTR+WCHK
      UTOTL=UTOTL+UCHK
      VTOTL=VTOTL+VCHK
      WTOTL=WTOTL+WCHK
C
      IF (NOUT.NE.0)
     1WRITE (6,721) K,XCPT(K),YCPT(K),ZCPT(K),UTOTR,VTOTR,WTOTR,UTOTL,
     1  VTOTL,WTOTL
  803 CONTINUE
C
C     SOURCE PANEL CONTRIBUTION
C
      IF(NTDAT.EQ.0) GO TO 835
      NJ=K
      CALL THKVEL(XCPT(K),YCPT(K),ZCPT(K))
      UTOTR=UTOTR+UTCHK
      VTOTR=VTOTR+VTCHK
      WTOTR=WTOTR+WTCHK
      UTOTL=UTOTL+UTCHK
      VTOTL=VTOTL-VTCHK
      WTOTL=WTOTL+WTCHK
      IF (NOUT.NE.0)
     1WRITE (6,721) K,XCPT(K),YCPT(K),ZCPT(K),UTOTR,VTOTR,WTOTR,UTOTL,
     1  VTOTL,WTOTL
  835 CONTINUE
C
      BDUSQ=UTOTR*UTOTR
      BDVSQ=VTOTR*VTOTR
      BDWSQ=WTOTR*WTOTR
      UBAR=UTOTR*COSALC-VTOTR*SINBET+WTOTR*SINALF
      ARG=1.0-FACTR2*(2.0*UBAR+BDUSQ+BDVSQ+BDWSQ)
      PRESSR(K)=-FACTR1
      IF(ARG.GE.TOTLR)PRESSR(K)=FACTR1*(ARG**3.5-1.0)
      BDUSQ=UTOTL*UTOTL
      BDVSQ=VTOTL*VTOTL
      BDWSQ=WTOTL*WTOTL
      UBAR=UTOTL*COSALC-VTOTL*SINBET+WTOTL*SINALF
      ARG=1.0-FACTR2*(2.0*UBAR+BDUSQ+BDVSQ+BDWSQ)
      PRESSL(K)=-FACTR1
      IF(ARG.GE.TOTLR)PRESSL(K)=FACTR1*(ARG**3.5-1.0)
      WRITE(6,720)K,XCPT(K),YCPT(K),ZCPT(K),UTOTR,VTOTR,WTOTR,
     1     PRESSR(K),UTOTL,VTOTL,WTOTL,PRESSL(K)
  813 CONTINUE
C
C
C     CALCULATE PRESSURE DIFFERENCES AT CONTROL POINTS
C
  801 CONTINUE
      WRITE (6,736)
      DO 821 K=1,NPANLS
      IF (K.LE.NHP) GO TO 822
      GO TO  823
  822 DLTP(K)=PRESSB(K)-PRESSA(K)
      GO TO 824
  823 DLTP(K)=PRESSR(K)-PRESSL(K)
  824 CONTINUE
  821 WRITE (6,720) K,XCPT(K),YCPT(K),ZCPT(K),DELTP(K),DLTP(K)
C
C     CALCULATE WING LOADINGS DUE TO BERNOULLI LOADING PRESSURES
C
      NPRESS=1
```

```
      CALL SPECLD
C
C
      RETURN
      END
```

```
      SUBROUTINE SPNLD
C
C     VERSION: DEMON1
C
C     THIS SUBROUTINE COMPUTES SPAN LOAD DISTRIBUTIONS
C     THIS SUBROUTINE COMPUTES SPAN LOAD DISTRIBUTIONS FOR MONOPLANE
C     OR CRUCIFORM WING OR FIN CONFIGURATIONS ONLY.
C NOTE: INTERDIGITATED FINS PRESENTLY EXCLUDED.
C     ALSO ADDITIONAL IN-PLANE FORCES,FY2,FZ2,
C     AND SUCTION DISTRIBUTIONS ALONG THE LEADING EDGE AND SIDE EDGE.
C     USING THIS INFORMATION, FIN LEADING AND SIDE EDGE VORTICITY
C     DISTRIBUTIONS ARE CALCULATED.
C     IN ADDITION, FIN TRAILING EDGE VORTEX STRENGTH AND SPANWISE
C     LOCATION ARE DETERMINED FROM THE LOAD DISTRIBUTIONS.
C
      DIMENSION SLOAD (20),CHORDS(150),FY2(150),FZ2(150),FT2(20),
     1 YCG(20),ZCG(20),VALMAX(5),YMAX(5),VALNUM(5),ZMAX(5),SLP(20),
     2 CIRNET(80),GAMMA(20)
C
      LOGICAL ASYM,ANYMO,SSLE
C
      COMMON/ONE/CIRC(250),DELTP(250),FN(250),PNLC(250),SWPPLE(250),
     1SWPPTE(250),VNOR(250),XBAR(250),ZBAR(250),XCPT(250),YCPT(250),ZCPT
     2(250),XLF(250),XLR(250),XRF(250),XRR(250),YLC(250),YRC(250),ZLF(25
     30),ZRF(250),ZLR(250),ZRR(250),SNT(125),CST(125),SNT2(125),CST2(125
     4),IP(300),XFBIP(100),A,ALFA,ALFR,ARWING,B2,B2V,BETA,BETAR,CONST,
     5COSALF,COSBET,CN,DX,EM,FMACH,RCIR,SINALF,SINBET,SLOPE,TIPRNC,TIPY,
     6TOTLR,U ,V ,W ,UCHK,VCHK,WCHK,WBIP,X,Y,Z,I,IF,II,J,MSWR,MSWL,MSWU,
     7MSWD,NBIP,NCRX,NCW,NDRAG,NHP,NPR,NRP,N3P,NOCPT,NULINP,NOUT,NPANLS,
     8NPRESS,NWBP,ASYM,BODY,DELTA,NOSYM
      COMMON/THREE/ANGLR,ANGLL,ANGLU,ANGLD,DELR,DELL,DELU,DELD,SREF,REFL
      COMMON/SWEEPS/VSWLER(20),VSWTER(20),VSWLEL(20),VSWTEL(20),
     1  VSWLEU(20),VSWTEU(20),VSWLED(20),VSWTED(20),LVSWP,LEFT,FAC,NCWB
     2,ARPNL(250),WIDTH(250)
      COMMON/FRCDIS/VNORDS(150),FX(150),FY(150),FZ(150),DLTPG(150),ANYMO
      COMMON/VRTXV/VVRTX(150),WVRTX(150),NVRTPL,NVRTX,VRTMAX
      COMMON/VRTHVL/VVEL(500),WVEL(500),JCPT,NCPOUT,NVLIN
      COMMON/FINLE/XLE(80),CGLOC(80),GAMLE(80),FKLE,NEDGV,MLEVR,MLEVL,
     1 MLEVU,MLEVD
      COMMON/FINSE/XSE(80),CGSELC(80),GAMSE(80),FKSE,NSIDGE,NSEV
      COMMON/ELLIPS/RA,RB,ERATIO
C
C
  702 FORMAT(////31X,22HSPANWISE DISTRIBUTIONS//)
  703 FORMAT (2X,I2,2X,8(F10.5,2X),F10.5,1X,2F10.5)
  704 FORMAT ( 2X,I2,2X,F10.5,2X,F10.5,74X,F10.5)
  706 FORMAT (1X,I3,2(1X,F10.5),5(2X,F10.5))
  707 FORMAT (////10X,22HSIDE EDGE DISTRIBUTION//2X,4HJTIP,2X,
     1   3HJSE,2X,8HDISTANCE,7X,13HSUCTION FORCE,7X,8HGAMMA,SE,6X,
     2 4HZBAR,7X,3HXSE/13X,7HFROM LE,8X,15HPER UNIT LENGTH,5X,
     3 5H/VINF/13X,9H/TIPCHORD,6X,15H/(J*TIPCHORD)/)
  708 FORMAT (////10X,22HSIDE EDGE DISTRIBUTION//2X,4HJTIP,2X,
     1   3HJSE,2X,8HDISTANCE,7X,13HSUCTION FORCE,7X,8HGAMMA,SE,6X,
     2 4HYBAR,7X,3HXSE/13X,7HFROM LE,8X,15HPER UNIT LENGTH,5X,
```

```
   3 5H/VINF/13X,9H/TIPCHORD,6X,13H/(Q*TIPCHORD)/)
709 FORMAT (3X,I2,4X,I2,1X,F10.5,6X,F10.5,6X,F10.5,4X,F10.5,1X,F10.5)
710 FORMAT (1X,I3,9(1X,F10.5))
712 FORMAT (////
   1 10X,9HSUMFX    = ,E12.5,/10X,9HSUMFY1 = ,E12.5,/10X,9HSUMFY2 = ,
   1E12.5,/10X,9HSUMFT2 = ,E12.5)
721 FORMAT(1H1,20(1H=),A10,21(1H=))
723 FORMAT( 3X,1HI,5X,7HZ/(B/2),2X,10HCN*C/(2*B),2X,10HCT*C/(2*B),
   1 1X,11HCZ1*C/(2*B),1X,13HCZTOT*C/(2*B),1X,10HCS*C/(2*B),5X,
   2 5HCSINT,5X,4HZBAR,7X,9HGAMNET(I),2X,13HGAMMA,LE/VINF,2X,3HXLE/)
724 FORMAT( 3X,1HI,5X,7HY/(B/2),2X,10HCN*C/(2*B),2X,10HCT*C/(2*B),
   1 1X,11HCY1*C/(2*B),1X,13HCYTOT*C/(2*B) ,1X,10HCS*C/(2*B),5X,
   2 5HCSINT,5X,4HYBAR,7X,9HGAMNET(I),2X,13HGAMMA,LE/VINF,2X,3HXLE/)
731 FORMAT (////10X,9HSUMFX   = ,E12.5/10X,9HSUMFZ1 = ,E12.5/10X,
   1 9HSUMFZ2 = ,E12.5/10X,9HSUMFT2 = ,E12.5/)
733 FORMAT (///,25X,17HWING PANEL FORCES//2X,1HJ,5X,7HYCPT(J),3X,
   18HDELTA-CP,6X,6HGAMMA/,6X,2HFX,10X,3HFY1, 9X,3HFY2/
   2 32X,4HVINF,//)
734 FORMAT (//8X,1HI,3X,3HDLT,6X,3HSLP,4X,4HISEQ,3X,4HYCHK,5X,
   1 6HVALINT,1X,4HNUM=,3X,6HVALMAX,3X,6HVALNUM,3X,4HYMAX/51X,3HEXT)
735 FORMAT (/7X,I2,2(1X,F8.4),2X,I2,1X,2(1X,F8.4),2X,I2,1X,
   1 3(1X,F8.4)/)
736 FORMAT (////30H*****T.E. FIN VORTEX INFO*****/)
738 FORMAT (1X,4HIVRT,1X,10HGAMMA/VINF,3X,6HY.C.G./)
739 FORMAT (///25X,17HWING PANEL FORCES//2X,1HJ,5X,7HZCPT(J),,3X,
   1 8HDELTA-CP,6X,6HGAMMA/,5X,2HFX,10X,3HFZ1,10X,3HFZ2,/
   2 18X,4HLIN.,10X,4HVINF,//)
742 FORMAT (1X,4HIVRT,1X,10HGAMMA/VINF,5X,6HZ.C.G./)
743 FORMAT (//8X,1HI,3X,3HDLT,6X,3HSLP,4X,4HISEQ,3X,4HZCHK,5X,
   1 6HVALINT,1X,4HNUM=,3X,6HVALMAX,3X,6HVALNUM,3X,4HZMAX/51X,3HEXT)
C
      DATA ARW/10HRIGHT WING/,ALW/10H LEFT WING/,AUW/10HUPPER WING/,
   1 ADW/10HLOWER WING/
C     INITIALIZE
C
      DO 903 I=1,50
  903 CIRNET(I)=0.0
C
C
C
C     CALCULATE SPANWISE LOAD DISTRIBUTIONS
C
      MSWRP=MSWR+1
      MSWLP=MSWL+1
      MSWUP=MSWU+1
      MSWDP=MSWD+1
      CFC=1.0/(4.0*B2)
      TWOB=4.0*B2
      ARGTAN=1.0/BETA
      ANGMCH=(ATAN(ARGTAN))*57.2957795
      PSIMCH=90.0-ANGMCH
C
C     LOOP 542 IS FOR RIGHT AND LEFT HORIZONTAL FINS
C
      HT=1.0/B2
      WRITE(6,721) ARW
      WRITE(6,702)
      WRITE(6,724)
      J=1
      TL=0
      ANGL=ANGLR
      SINANG=SIN(ANGL)
      COSANG=COS(ANGL)
```

```
      NSPANP=MSWRP
      SIGN=+1.0
      KUL=MSWRP
      JSTART=1
      JEND=NRP
      JTIP=NRP-NCW+1
      TIPCHD=XRB(NRP)-XRF(JTIP)
      IVRT=0
      IFV=0
  540 CONTINUE
      CIRNET(NSPANP)=0.0
      I=0
C
C
      SUMFX=0.0
      SUMFY1=0.0
      SUMFY2=0.0
      SUMFT2=0.0
C
C
      SLP(1)=0.0
      DLT=0.
      VALINT=0.0
      CSINT=0.0
      CSMOM=0.0
      NUMEXT=0
      ISEQ=0
      NOEXT=0
C
C     ALL CIRNET ARE POSITIVE IN THE COUNTER CLOCKWISE DIRECTION LOOKING
C     FORWARD
C     NOTE: IN PLANE FORCE FY2 ACTS ON OUTBOARD AFT CORNER OF EACH PANEL
C     HERE:  IL=0.....RIGHT FIN
C            IL=1.....LEFT FIN
C
      DO 542 K=2,KUL
      I=I+1
      IFV=IFV+1
      SCSMX=0.0
      SCSMY1=0.0
      SCSMY2=0.0
      SWPANG=ABS(ATAN(SWPPLE(J)))
      COSSWP=COS(SWPANG)
      PSIPLE=SWPANG*57.2957795
      SSLE=PSIMCH.GT.PSIPLE
      SUM1=0.0
      YCHK=YCPT(J)*COSBET-XBAR(J)*SINBET
      IF (ANYMO) YCHK=YCPT(J)
      YLOC=YCHK*BTW
      IP1=I+1
      IF (IL.EQ.1) GO TO 460
      NFRST=1
      ISPN=IP1
      IC=I
      XLE(IFV)=XLF(J)+(YCPT(J)-YLC(J))*SWPPLE(J)
      GO TO 461
  460 NFRST=MSWRP+1
      ISPN=IP1+MSWRP
      IC=I+MSWRP
      XLE(IFV)=XRF(J)+(YCPT(J)-YRC(J))*SWPPLE(J)
  461 CONTINUE
      CIRNET(ISPN)=0.0
      DO 541 L=1,NCW
```

```
      SUM1=SUM1+FN(J)
      WIDI=1./WIDTH(J)
      IF (I.NE.1) GO TO 812
      CIRNET(NFRST)=CIRNET(NFRST)-CIRC(J)*SIGN
  812 JADJ=J+NCW
      IF (K.EQ.KUL) GO TO 916
      GO TO 917
  916 CIRNET(NSPANP)=CIRNET(NSPANP)+CIRC(J)*SIGN
      GO TO 813
  917 CIRNET(ISPN)=CIRNET(ISPN)+(CIRC(J)-CIRC(JADJ))*SIGN
  813 CONTINUE
      IF (NDRAG.EQ.0) GO TO 815
      IF(IL.EQ.1) GO TO 440
      CHORDS(J)=XRB(J)-XRF(J)
      GO TO 441
  440 CHORDS(J)=XLB(J)-XLF(J)
  441 CONTINUE
      IF (L.EQ.NCW) CHORDS(J)=0.5*CHORDS(J)
      FY2(J)=2.0*CHORDS(J)*CIRNET(ISPN)*(SINANG+VNORDS(J))
      IF (FX(J).LT.0.0.OR.SSLE) GO TO 818
      SCSMX=SCSMX+FX(J)
      SCSMY1=SCSMY1+FY(J)
  818 CONTINUE
      IF (K.EQ.KUL) GO TO 816
      SCSMY2=SCSMY2+FY2(J)
      GO TO 815
  816 FT2(L)=FY2(J)
      SUMFT2=SUMFT2+FT2(L)
  815 CONTINUE
C
C     WIDTH(J) IS PANEL SPANWISE DIMENSION,ALWAYS POSITIVE.
C     IT IS CALCULATED IN SUBROUTINE LAYOUT.
C
  541 J=J+1
      DELY=WIDTH(J-1)
      SUMFX=SUMFX+SCSMX
      SUMFY1=SUMFY1+SCSMY1
      SUMFY2=SUMFY2+SCSMY2
      FACTOR=WIDI*CFC
C
C     SLOAD....CNC/2B,SECFXX....CTC/IB,SECFY....CYC/2B,SECFY2....CY(TOT)
C     /2B,SECSUC....CSC/2B
C     VALINT.....ACCUMULATED VALUE OF THE INTEGRAL (CNC/2*B)*DELY OVER
C     THE SPANWISE DIRECTION.
C     CSINT.....ACCUMULATED VALUE OF THE INTEGRAL (CSC/2*B)*DELY OVER
C     THE SPANWISE DIRECTION.
C
      SLOAD(I)=SUM1*WIDI*CFC
      VALINT=VALINT+(SLOAD(I)*DELY)
      IF (NDRAG.NE.0) GO TO 562
      WRITE (6,703) IC,YLOC,SLOAD(I),CIRNET(IC)
      IF (K.NE.KUL) GO TO 542
      YLOC=((B2+RB)/B2)*SIGN
      SLDTIP=0.0
      WRITE (6,704) NSPANP,YLOC,SLDTIP,CIRNET(NSPANP)
      GO TO 542
  562 CONTINUE
      IF (SSLE) GO TO 551
      SECFXX=SCSMX*FACTOR
      SECFY=SCSMY1*FACTOR
      SECFY2=(SCSMY2+SCSMY1)*FACTOR
      SECSUC=SECFXX/COSSWP
      CSINT=CSINT+(SECSUC*DELY)
```

```
      CSMOM=CSMOM+ABS(YCHK*SECSUC*DELY)
      CGLOC(IFV)=(CSMOM/CSINT)*SIGN
      YEXP=CGLOC(IFV)-(RB*SIGN)
      GAMLE(IFV)=FKLE*((CSINT*THOH)/(2.0*YEXP))*COSANG
      GO TO 552
  551 SECFXX=0.0
      SECFY=0.0
      SECFY2=SCSMY2*FACTOR
      SECSUC=0.0
      CGLOC(IFV)=0.0
      GAMLE(IFV)=0.0
  552 CONTINUE
      WRITE (6,703) IC,YLOC,SLOAD(I),SECFXX,SECFY,SECFY2,SECSUC,CSINT,
     1 CGLOC(IFV),CIRNET(IC),GAMLE(IFV),XLE(IFV)
      IF (K.NE.KUL) GO TO 525
      YLOC=((B2+RB)/B2)*SIGN
      SLOTIP=0.0
      WRITE (6,704) NSPANP,YLOC,SLOTIP,CIRNET(NSPANP)
  525 CONTINUE
      IF (I.EQ.1) GO TO 645
      IM1=I-1
      DLT=ABS(YCHK-YCHKBF)
      SLP(I) =(SLOAD(I)-SLOAD(IM1))/DLT
      REFSLP=ABS(SLOAD(1)/(10.0*B2))
      IF (ABS(SLP(I)).LE.REFSLP) SLP(I)=0.0
      IF (I.EQ.2) GO TO 646
      IF (K.EQ.KUL) GO TO 521
      GO TO 522
  521 SLP(NSPANP)=-SLOAD(I)/(DLT/2.0)
      IF (ABS(SLP(NSPANP)).LE.REFSLP) GO TO 646
      SLPCHK=SLP(I)
      IF (SLPCHK.EQ.0.0) SLPCHK=SLP(I-1)
      IF (SLPCHK.GT.0.0.AND.SLP(NSPANP).LT.0.0) GO TO 643
      IF (SLPCHK.LT.0.0.AND.SLP(NSPANP).GT.0.0) GO TO 643
  522 CONTINUE
      IF (SLP(I).EQ.0.0) GO TO 646
      IF (SLPBF.EQ.0.0.AND.I.GE.4) SLPBF=SLP(I-2)
      IF (SLPBF.GT.0.0.AND.SLP(I).LT.0.0) GO TO 643
      IF (SLPBF.LT.0.0.AND.SLP(I).GT.0.0) GO TO 643
      GO TO 646
C
C     VALMAX IS THE EXTREME VALUE OF CNC/2*B
C     ITS VALUE IS TAKEN EQUAL TO THE (I-1)TH VALUE OF CNC/2B
C     LIKEWISE YMAX
C     VALMAX(1) IS THE VALUE OF CNC/2B NEAREST THE ROOT
C
  643 NUMEXT=NUMEXT+1
      ISEQ=NUMEXT+1
      VALMAX(1)=SLOAD(1)
      YMAX(1)=RB*SIGN
      VALMAX(ISEQ  )=SLOAD(IM1)
      YMAX(ISEQ  )=YCHKBF
      IF (IL.EQ.0) YOUTSD=YRC(J-1-NCW)
      IF (IL.EQ.1) YOUTSD=YLC(J-1-NCW)
      RSINT=SLOAD(IM1)*(YOUTSD-YMAX(ISEQ))*SIGN
      VALINT=RSINT+(SLOAD(I)*DELY)
      VALNUM(ISEQ)=VLINBF-RSINT
  646 SLPBF=SLP(I)
  645 YCHKBF=YCHK
      VLINBF=VALINT
      IF (K.EQ.KUL.AND.NUMEXT.EQ.0) GO TO 526
      GO TO 527
  526 VALMAX(1)=SLOAD(1)
```

```
      YMAX(I)=YCHK
      VALNUM(I)=VALINT
      NDEXT=1
  527 CONTINUE
      IF (I.EQ.1.AND.NOUT.NE.0) WRITE (6,734)
      IF (NOUT.NE.0) WRITE (6,735) I,DLT,SLP(I),ISEQ,YCHK,VALINT,NUMEXT,
     1 VALMAX(ISEQ   ),VALNUM(ISEQ   ),YMAX(ISEQ   )
      IF (NOUT.NE.0.AND.K.EQ.KUL) WRITE (6,735) IP1,    DLT,SLP(NSPANP),
     1 ISEQ,YCHK,VALINT,NUMEXT,VALMAX(ISEQ),VALNUM(ISEQ),YMAX(ISEQ)
  542 CONTINUE
C
      SUMFX=SUMFX/SREF
      SUMFY1=SUMFY1/SREF
      SUMFY2=SUMFY2/SREF
      SUMFT2=SUMFT2/SREF
      WRITE (6,712) SUMFX,SUMFY1,SUMFY2,SUMFT2
C
C     SIDE FORCE PER UNIT TIPCHORD/(Q*C)
C
      IF (NDRAG.EQ.0) GO TO 600
      IF (TIPCHD.LT.100.0*TLRNC) GO TO 600
      TIPEPL=TIPCHD/NCW
      DENOM=TIPCHD*TIPEPL
      WRITE (6,708)
      JSE=0
      FACTRK= 1.0/(FKLE*TWOB)
      FACTRI=1.0/FACTRK
      DO 914 JTIP=1,NCW
      AJTIP=JTIP
      XLOC=AJTIP*TIPEPL
      XLOCOC=XLOC/TIPCHD
      FT=FT2(JTIP)/DENOM
      JSE=JSE+1
      IF (IL.EQ.1) GO TO 918
      J=NRP-NCW+JTIP
      XSE(JSE)=XRF(J)
      GO TO 919
  918 J=NHP-NCW+JTIP
      XSE(JSE)=XLF(J)
  919 CSMOM=CSMOM+ABS((RB+R2)*FACTRK*FT2(JTIP)*FKSE)
      CSINT=CSINT+ABS(FACTRK*FT2(JTIP)*FKSE)
      CGSELC(JSE)=(CSMOM/CSINT)*SIGN
      YEXP=CGSELC(JSE)-(RB*SIGN)
      GAMSE(JSE)=((CSINT*FACTRI)/(2.0*YEXP))*COSANG
  914 WRITE (6,709) JTIP,JSE,XLOCOC,FT,GAMSE(JSE),CGSELC(JSE),XSE(JSE)
  600 CONTINUE
C
C
C     PRINT INDIVIDUAL PANEL FORCES
C
      IF (NOUT.NE.1) GO TO 548
      WRITE (6,733)
      DO 550 J=JSTART,JEND
  550 WRITE (6,706) J,YCPT(J),DLTPG(J),CIRC(J),FX(J),FY(J),FY2(J)
  548 CONTINUE
C
C
C
C
C     FIN TRAILING EDGE VORTICES CALCULATED NEXT.
C     GAMMA.....GAMMA/VINF,POSITIVE COUNTERCLOCKWISE.
C     YCG.......YBAR,MEASURED FROM BODY CENTERLINE.
C
```

```
      IF (NOMAG.EQ.0) GO TO 531
      WRITE (6,736)
      WRITE (6,738)
      IF (NOEXT.EQ.0) GO TO 528
      IVRT=IVRT+1
      GAMMA(IVRT )=(SLOAD(1)*TWOB/2.0)*SIGN
      YCG(IVRT)=(RB+(VALNUM(1)/SLOAD(1)))*SIGN
      WRITE (6,710) IVRT,GAMMA(IVRT),YCG(IVRT)
      GO TO 531
  528 CONTINUE
      NLST=NUMEXT+1
      DO 650 ISEQ=1,NLST
      IVRT=IVRT+1
      ISEQP1=ISEQ+1
      IF (ISEQ.EQ.NLST) GO TO 534
      DIFMAX=VALMAX(ISEQP1)-VALMAX(ISEQ)
      GAMMA(IVRT)=-(TWOB/2.0)*DIFMAX*SIGN
      YCG(IVRT)= ((YMAX(ISEQP1)*VALMAX(ISEQP1)-YMAX(ISEQ)*VALMAX(ISEQ))
     1 /DIFMAX)-(VALNUM(ISEQP1)/DIFMAX)*SIGN
      GO TO 533
  534 GAMMA(IVRT)=(TWOB/2.0)*VALMAX(ISEQ)*SIGN
      YCG(IVRT)=YMAX(ISEQ)+(VALINT/VALMAX(ISEQ))*SIGN
  533 CONTINUE
      WRITE (6,710) IVRT,GAMMA(IVRT),YCG(IVRT)
  650 CONTINUE
  531 CONTINUE
C
C
      IF (MSWL.EQ.0) GO TO 549
      IF(IL.NE.0) GO TO 543
C
C     RE-ENTER ABOVE LOOP FOR LEFT HORIZONTAL WING
C
      IL=1
      KUL=MSWLP
      JSTART=NRP+1
      JEND=NMP
      JTIP=NMP-MCW+1
      TIPCHD=XLB(NMP)-XLF(JTIP)
      WRITE(6,721) ALW
      WRITE (6,702)
      WRITE(6,724)
      ANGL=ANGLL
      SINANG=SIN(ANGL)
      COSANG=COS(ANGL)
      NSPANP=NSPANP+MSWLP
      SIGN=-1.0
      J=NRP+1
      GO TO 540
  543 IF(MSWU.EQ.0) GO TO 549
C
C     LOOP 546 IS FOR UPPER AND LOWER FINS
C     HERE   IL=0....UPPER FIN
C            IL=1.....LOWER FIN
C
C
      BTW=1.0/B2V
      TWOB=4.0*B2V
      WRITE(6,721) AUW
      WRITE (6,702)
      WRITE(6,723)
      KU=MSWUP
      IL=0
```

```
      ANGL=ANGLU
      SINANG=SIN(ANGL)
      COSANG=COS(ANGL)
      NSPANP=MSWUP+NSPANP
      SIGN=+1.0
      J=NHP+1
      JSTART=NHP+1
      JEND=N3P
      JTIP=N3P-NCW+1
      TIPCHD=XRB(N3P)-XRF(JTIP)
  544 CONTINUE
      CIRNET(NSPANP)=0.0
      I=0
      SUMFX=0.0
      SUMFZ1=0.0
      SUMFZ2=0.0
      SUMFT2=0.0
      SLP(1)=0.0
      DLT=0.0
      VALINT=0.0
      CSINT=0.0
      CSMOM=0.0
      NUMEXT=0
      ISEQ=0
      NOEXT=0
      DO 546 K=2,KU
      I=I+1
      IFV=IFV+1
      SCSMX=0.0
      SCSMZ1=0.0
      SCSMZ2=0.0
      SUM1=0.0
      SWPANG=ABS(ATAN(SWPPLE(J)))
      COSSWP=COS(SWPANG)
      PSIPLE=SWPANG*57.2957795
      SSLE=PSIMCH.GT.PSIPLE
      ZCHK=ZCPT(J)*COSALF+XBAR(J)*SINALF
      IF (ANYMO  ) ZCHK=ZCPT(J)
      ZLOC=ZCHK+HTW
      IP1=I+1
      IF (IL.EQ.1) GO TO 560
      NFRST=MSWRP+MSWLP+1
      ISPN=IP1+MSWRP+MSWLP
      IC=I+MSWRP+MSWLP
      XLE(IFV)=XLF(J)+(ZCPT(J)-ZLF(J))*SWPPLE(J)
      GO TO 561
  560 NFRST=MSWRP+MSWLP+MSWUP+1
      ISPN=IP1+MSWRP+MSWLP+MSWUP
      IC=I+MSWRP+MSWLP+MSWUP
      XLE(IFV)=XRF(J)+(ZCPT(J)-ZRF(J))*SWPPLE(J)
  561 CONTINUE
      CIRNET(ISPN)=0.0
C
C   NOTE: IN PLANE FORCE FZ2 ACTS ON OUTBOARD AFT CORNER OF EACH PANEL
C
C   HERE: IL=0....UPPER FIN
C         IL=1....LOWER FIN
C
      DO 545 L=1,NCW
      SUM1=SUM1+FN(J)
      WIDI=1./WIDTH(J)
      IF (I.NE.1) GO TO 212
      CIRNET(NFRST)=CIRNET(NFRST)-CIRC(J)*SIGN
```

```
212 JADJ=J+NCW
    IF (K.EQ.KU) GO TO 216
    GO TO 217
216 CIRNET(NSPANP)=CIRNET(NSPANP)+CIRC(J)*SIGN
    GO TO 213
217 CIRNET(ISPN)=CIRNET(ISPN)+(CIRC(J)-CIRC(JADJ))*SIGN
213 CONTINUE
    IF (NDRAG.EQ.0) GO TO 317
    IF (IL.EQ.1) GO TO 340
    CHORDS(J)=XRB(J)-XRF(J)
    GO TO 341
340 CHORDS(J)=XLB(J)-XLF(J)
341 CONTINUE
    IF (L.EQ.NCW) CHORDS(J)=0.5*CHORDS(J)
    FZ2(J)=2.0*CHORDS(J)*CIRNET(ISPN)*(SINANG-VNORDS(J))
    IF (FX(J).LT.0.0.OR.SSLE) GO TO 342
    SCSMX=SCSMX+FX(J)
    SCSMZ1=SCSMZ1+FZ(J)
342 CONTINUE
    IF (K.EQ.KUL) GO TO 316
    SCSMZ2=SCSMZ2+FZ2(J)
    GO TO 317
316 FT2(L)=FZ2(J)
    SUMFT2=SUMFT2+FT2(L)
317 CONTINUE
545 J=J+1
    DELZ=WIDTH(J-1)
    SUMFX=SUMFX+SCSMX
    SUMFZ1=SUMFZ1+SCSMZ1
    SUMFZ2=SUMFZ2+SCSMZ2
C
    FACTOR=WIDI*CFC
    SLOAD(I)=SUMI*FACTOR
    VALINT=VALINT+(SLOAD(I)*DELZ)
    IF (NDRAG.NE.0) GO TO 563
    WRITE (6,704) IC,ZLOC,SLOAD(I),CIRNET(IC)
    IF (K.NE.KU) GO TO 546
    ZLOC=((B2V+RA)/B2V)*SIGN
    SLDTIP=0.0
    WRITE (6,704) NSPANP,ZLOC,SLOAD(I),CIRNET(NSPANP)
    GO TO 546
563 CONTINUE
    IF (SSLE) GO TO 851
    SECFXX=SCSMX*FACTOR
    SECFZ=SCSMZ1*FACTOR
    SECFZ2=(SCSMZ2+SCSMZ1)*FACTOR
    SECSUC=SECFXX/COSSWP
    CSINT=CSINT+(SECSUC*DELZ)
    CSMOM=CSMOM+ABS(ZCHK*SECSUC*DELZ)
    CGLOC(IFV)=(CSMOM/CSINT)*SIGN
    ZEXP=CGLOC(IFV)-(RA*SIGN)
    GAMLE(IFV)=FKLE*((CSINT*T*OB)/(2.0*ZEXP))*COSANG
    GO TO 852
851 SECFXX=0.0
    SECFZ=0.0
    SECFZ2=SCSMZ2*FACTOR
    SECSUC=0.0
    CGLOC(IFV)=0.0
    GAMLE(IFV)=0.0
852 CONTINUE
    WRITE (6,703) IC,ZLOC,SLOAD(I),SECFXX,SECFZ,SECFZ2,SECSUC,CSINT,
   1 CGLOC(IFV),CIRNET(IC ),GAMLE(IFV),XLE(IFV)
    IF (K.NE.KUL) GO TO 564
```

```
      ZLOC=((B2V+RA)/B2)*SIGN
      SLDTIP=0.0
      WRITE (6,704) NSPANP,ZLOC,SLDTIP,CIRNET(NSPANP)
  564 CONTINUE
      IF (I.EQ.1) GO TO 845
      IM1=I-1
      DLT=ABS(ZCHK-ZCHKBF)
      SLP(I) =(SLOAD(I)-SLOAD(IM1))/DLT
      REFSLP=ABS(SLOAD(1)/(10.0*B2V))
      IF (ABS(SLP(I)).LE.REFSLP) SLP(I)=0.0
      IF (I.EQ.2) GO TO 846
      IF (K.EQ.KU) GO TO 821
      GO TO 822
  821 SLP(NSPANP)=-SLOAD(I)/(DLT/2.0)
      IF (ABS(SLP(NSPANP)).LE.REFSLP) GO TO 846
      SLPCHK=SLP(I)
      IF (SLPCHK.EQ.0.0) SLPCHK=SLP(I-1)
      IF (SLPCHK.GT.0.0.AND.SLP(NSPANP).LT.0.0) GO TO 843
      IF (SLPCHK.LT.0.0.AND.SLP(NSPANP).GT.0.0) GO TO 843
  822 CONTINUE
      IF (SLP(I).EQ.0.0) GO TO 846
      IF (SLPBF.EQ.0.0.AND.I.GE.4) SLPBF=SLP(I-2)
      IF (SLPBF.GT.0.0.AND.SLP(I).LT.0.0) GO TO 843
      IF (SLPBF.LT.0.0.AND.SLP(I).GT.0.0) GO TO 843
      GO TO 846
  843 NUMEXT=NUMEXT+1
      ISEQ=NUMEXT+1
      VALMAX(1)=SLOAD(1)
      ZMAX(1)=RA*SIGN
      VALMAX(ISEQ)=SLOAD(IM1)
      ZMAX(ISEQ)=ZCHKBF
      IF (IL.EQ.0) ZOUTSD=ZRB(J-1-NCW)
      IF (IL.EQ.1) ZOUTSD=ZLB(J-1-NCW)
      RSINT=SLOAD(IM1)*(ZOUTSD-ZMAX(ISEQ))*SIGN
      VALINT=RSINT+(SLOAD(I)*DELZ)
      VALNUM(ISEQ)=VLINBF-RSINT
  846 SLPBF=SLP(I)
  845 ZCHKBF=ZCHK
      VLINBF=VALINT
      IF (K.EQ.KU.AND.NUMEXT.EQ.0) GO TO 826
      GO TO 827
  826 VALMAX(1)=SLOAD(1)
      ZMAX(1)=ZCHK
      VALNUM(1)=VALINT
      NOEXT=1
  827 CONTINUE
      IF (I.EQ.1.AND.NOUT.NE.0) WRITE (6,743)
      IF (NOUT.NE.0) WRITE (6,735) I,DLT,SLP(I),ISEQ,ZCHK,VALINT,NUMEXT,
     1 VALMAX(ISEQ),VALNUM(ISEQ),ZMAX(ISEQ)
      IF (NOUT.NE.0.AND.K.EQ.KU ) WRITE (6,735) IP1,   DLT,SLP(NSPANP),
     1 ISEQ,ZCHK,VALINT,NUMEXT,VALMAX(ISEQ),VALNUM(ISEQ),ZMAX(ISEQ)
  546 CONTINUE
C
      SUMFX=SUMFX/SREF
      SUMFZ1=SUMFZ1/SREF
      SUMFZ2=SUMFZ2/SREF
      SUMFT2=SUMFT2/SREF
      WRITE (6,731) SUMFX,SUMFZ1,SUMFZ2,SUMFT2
C
C
C     SIDE FORCE PER UNIT TIPCHORD/(Q*C)
C
      IF (NDRAG.EQ.0) GO TO 400
```

```
      IF (TIPCHD.LT.100.0*TLRNC) GO TO 400
      TIPEPL=TIPCHD/NCW
      DENOM=TIPCHD*TIPEPL
      WRITE (6,707)
      FACTRK= 1.0/(FKLE*TWOP)
      FACTRI=1.0/FACTRK
      DO 414 JTIP=1,NCW
      AJTIP=JTIP
      XLOC=AJTIP*TIPEPL
      XLOCOC=XLOC/TIPCHD
      FT=FT2(JTIP)/DENOM
      JSE=JSE+1
      IF (IL.EQ.1) GO TO 920
      J=N3P-NCW+JTIP
      XSE(JSE)=XRF(J)
      GO TO 921
  920 J=NPANLS-NCW+JTIP
      XSE(JSE)=XLF(J)
  921 CSMOM=CSMOM+ABS((RA+B2)*FACTRK*FT2(JTIP)*FKSE)
      CSINT=CSINT+ABS(FACTRK*FT2(JTIP)*FKSE)
      CGSELC(JSE)=(CSMOM/CSINT)*SIGN
      ZEXP=CGSELC(JSE)-(RA*SIGN)
      GAMSE(JSE)=((CSINT*FACTRI)/(2.0*ZEXP))*COSANG
  414 WRITE (6,709) JTIP,JSE,XLOCOC,FT,GAMSE(JSE),CGSELC(JSE),XSE(JSE)
  400 CONTINUE
C
C     PRINT INDIVIDUAL PANEL FORCES
C
      IF (NOUT.EQ.0) GO TO 448
      WRITE (6,739)
      DO 450 J=JSTART,JEND
  450 WRITE (6,706) J,ZCPT(J),DLTPG(J),CIRC(J),FX(J),FZ(J),FZ2(J)
  448 CONTINUE
C
C     FIN TRAILING EDGE VORTICES CALCULATED NEXT.
C     GAMMA.....GAMMA/VINF,POSITIVE COUNTERCLOCKWISE.
C     ZCG.......ZBAR,MEASURED FROM BODY CENTERLINE.
C
      IF (NDRAG.EQ.0) GO TO 631
      WRITE (6,736)
      WRITE (6,742)
      IF (NOEXT.EQ.0) GO TO 628
      IVRT=IVRT+1
      GAMMA(IVRT)= (SLOAD(1)*TWOB/2.0)*SIGN
      ZCG(IVRT)=(RA+(VALNUM(1)/SLOAD(1)))*SIGN
      WRITE (6,710) IVRT,GAMMA(IVRT),ZCG(IVRT)
      GO TO 631
  628 CONTINUE
      NLST=NUMEXT+1
      DO 651 ISEQ=1,NLST
      IVRT=IVRT+1
      ISEQP1=ISEQ+1
      IF (ISEQ.EQ.NLST) GO TO 634
      DIFMAX=VALMAX(ISEQP1)-VALMAX(ISEQ)
      GAMMA(IVRT)=-(TWOB/2.0)*DIFMAX*SIGN
      ZCG(IVRT)= ((ZMAX(ISEQP1)*VALMAX(ISEQP1)-ZMAX(ISEQ)*VALMAX(ISEQ))
     1 /DIFMAX)-(VALNUM(ISEQP1)/DIFMAX)*SIGN
      GO TO 633
  634 GAMMA(IVRT)=(TWOB/2.0)*VALMAX(ISEQ)*SIGN
      ZCG(IVRT)=ZMAX(ISEQ)+(ABS(VALINT/VALMAX(ISEQ)))*SIGN
  633 CONTINUE
      WRITE (6,710) IVRT,GAMMA(IVRT),ZCG(IVRT)
  651 CONTINUE
```

```
  631 CONTINUE
C
C
C     RE-ENTER ABOVE LOOP FOR LOWER WING
C
      IF(IL.NE.0) GO TO 549
      WRITE(6,721) ADW
      WRITE (6,702)
      WRITE(6,723)
      IL=1
      KU=MSWD+1
      JSTART=N3P+1
      JEND=NPANLS
      ANGL=ANGLD
      SINANG=SIN(ANGL)
      NSPANP=NSPANP+MSWDP
      SIGN=-1.0
      J=N3P+1
      JTIP=NPANLS-NCW+1
      TIPCHD=XLB(NPANLS)-XLF(JTIP)
      GO TO 544
  549 CONTINUE
C
C
      RETURN
      END
```

```
      SUBROUTINE THETIN(MSW,MT)
C
C     VERSION: DEMON1
C
C     THIS ROUTINE READS THICKNESS SLOPES FOR AN ARBITRARY WING.
C
      COMMON/THKDAT/NTDAT,NCWT,NTPR,MSWT(4),NRPT,NHPT,N3PT,NTHP,ASYMT,
     1       NVERT,SWLET(20,4),SWTET(20,4),YTH(20,4),THETAL(400)
      COMMON/THTAS/NUNIS,THET(400)
C
  500 FORMAT(8F10.0)
C
      MT=NCWT*MSW
      IF(NUNIS.NE.0) GO TO 5
      MN=0
      DO 1 JN=1,MT,NCWT
      MN=MN+NCWT
    1 READ(5,500) (THET(J),J=JN,MN)
      RETURN
    5 READ(5,500) (THET(J),J=1,NCWT)
      DO 6 J=2,MSW
      JJ=(J-1)*NCWT
      DO 6 K=1,NCWT
      KK=JJ+K
    6 THET(KK)=THET(K)
      RETURN
      END
```

```
      SUBROUTINE THKIN
C
C     VERSION: DEMON1
C
C     SUBROUTINE TO INPUT THICKNESS DATA.
C
      LOGICAL ASYMT
      COMMON/THKDAT/NTDAT,NCWT,NTPP,MSWT(4),NRPT,NHPT,N3PT,NTHP,ASYMT,
     1       NVERT,SWLET(20,4),SWTET(20,4),YTH(20,4),THETAL(400)
      COMMON/TSPANS/SPANR,SPANL,SPANU,SPAND,SWPLER,SWPLEL,SWPLEU,
     1       SWPLED,SWPTER,SWPTEL,SWPTEU,SWPTED,RBOD
      COMMON/THTAS/NUNIS,THET(400)
C
  500 FORMAT(10I5)
  510 FORMAT(3F10.0)
C
C
C     INITIALIZE INDICES
C
      NLP=0
      NUP=0
      NDP=0
C
C           INPUT RIGHT WING DATA.
C
      READ(5,500) MSWT(1),LVSWT,NUNIS
      MSWP=MSWT(1)+1
C
C           IF SIDESLIP IS NON-ZERO OR IF LVSWT=0, SPANWISE SPACINGS
C           ARE NOT READ IN.  THEY MUST BE CALCULATED AND EQUALLY
C           SPACED.  NO BREAKS IN SWEEP ARE ALLOWED.
C
      IF(ASYMT.OR.LVSWT.EQ.0) GO TO 5
      READ(5,510) (YTH(I,1),SWLET(I,1),SWTET(I,1),I=1,MSWP)
      GO TO 10
    5 CALL EDGES(MSWP,SPANR,RBOD,SWPLER,SWPTER,YTH(1,1),SWLET(1,1),
     1           SWTET(1,1))
   10 CONTINUE
C
C           SUBROUTINE THETIN READS THICKNESS SLOPES.
C
      CALL THETIN(MSWT(1),NRPT)
      DO 15 I=1,NRPT
   15 THETAL(I)=THET(I)
      IF(NTDAT.EQ.1) GO TO 40
C
C           INPUT LEFT WING DATA IF SIDESLIP IS NON-ZERO, WING ALONE.
C
      IF(.NOT.ASYMT) GO TO 25
      READ(5,500) MSWT(2),LVSWT,NUNIS
      MSWP=MSWT(2)+1
      CALL EDGES(MSWP,-SPANL,-RBOD,-SWPLEL,-SWPTEL,YTH(1,2),
     1           SWLET(1,2),SWTET(1,2))
      CALL THETIN(MSWT(2),NLP)
      DO 20 I=1,NLP
   20 THETAL(I+NRPT)=THET(I)
C
C     INPUT UPPER WING DATA IF VERTICAL WINGS ARE PRESENT
C           AND THEIR GEOMETRY IS DIFFERENT FROM HORIZONTAL WINGS.
C           NOTE THAT NTDAT IS NOW NE 1.
C
   25 CONTINUE
      IF(NVERT.EQ.0) GO TO 50
      READ(5,500) MSWT(3),LVSWT,NUNIS
```

```
      MSWP=MSWT(3)+1
      IF(ASYMT.OR.LVSWT.EQ.0) GO TO 27
      READ(5,510) (YTH(I,3),SWLET(I,3),SWTET(I,3),I=1,MSWP)
      GO TO 28
   27 CALL EDGES(MSWP,SPANU,RHOD,SWPLEU,SWPTEU,YTH(1,3),SWLET(1,3),
     1           SWTET(1,3))
   28 CONTINUE
      CALL THETIN(MSWT(3),NUP)
      DO 30 I=1,NUP
   30 THETAL(NRPT+NLP+I)=THET(I)
C
C           INPUT LOWER WING DATA IF SIDESLIP IS NON-ZERO, WING ALONE.
C
      IF(.NOT.ASYMT) GO TO 50
      READ(5,500) MSWT(4),LVSWT,NUNIS
      MSWP=MSWT(4)+1
      CALL EDGES(MSWP,-SPAND,-RHOD,-SWPLED,-SWPTED,YTH(1,4),SWLET(1,4),
     1           SWTET(1,4))
      CALL THETIN(MSWT(4),NDP)
      DO 35 I=1,NDP
   35 THETAL(NRPT+NLP+NUP+I)=THET(I)
      GO TO 50
C
C     ALL DATA INPUT AT THIS POINT.
C
C           SET UPPER WING EQUAL TO RIGHT WING IN SYMMETRIC
C           CASE (NTDAT=1 AND NVERT NE 0)
C
   40 CONTINUE
      IF(NVERT.EQ.0) GO TO 50
      MSWT(3)=MSWT(1)
      MSWP=MSWT(1)+1
      DO 45 I=1,MSWP
      YTH(I,3)=YTH(I,1)
      SWLET(I,3)=SWLET(I,1)
   45 SWTET(I,3)=SWTET(I,1)
      NUP=NRPT
      DO 46 I=1,NRPT
   46 THETAL(NRPT+I)=THETAL(I)
C
C     CALCULATE INDICES.
C
   50 CONTINUE
      NHPT=NRPT+NLP
      N3PT=NHPT+NUP
      NTHP=N3PT+NDP
C
      RETURN
      END


      SUBROUTINE THKLYT(CRP,IL)
C
C     VERSION: DEMON1
C
C     THIS ROUTINE LAYS OUT SOURCE PANELS ON A SINGLE WING SURFACE.
C
      DIMENSION NDP(3)
C
      COMMON/ONE/CIRC(250),DELTP(250),FN(250),PNLC(250),SWPPLE(250),
     1SWPPTE(250),VNOR(250),XBAR(250),ZBAR(250),XCPT(250),YCPT(250),ZCPT
```

```
     2(250),XLF(250),XLB(250),XRF(250),XRB(250),YLC(250),YRC(250),ZLF(250
     3),ZRF(250),ZLB(250),ZRB(250),SNT(125),CST(125),SNT2(125),CST2(125
     4),IP(300),XFBIP(100),A,ALFA,ALFR,ARWING,B2,B2V,BETA,BETAR,CONST,
     5COSALF,COSBET,CN,DX,EM,FMACH,RB,SINALF,SINBET,SLOPE,TLRNC,TIPY,
     6TOTLR,U,V,W,UCHK,VCHK,WCHK,WBIP,X,DUMY,Z,I,IF,II,J,MSWR,MSWL,MSWU,
     7MSWD,NBIP,NCRX,NCW,NDRAG,NHP,NPR,NRP,NSP,NOCPT,NOLINP,NOUT,NPANLS,
     8NPRESS,NWAP,ASYM,BODY,DELTA,NOSYM
      COMMON/THKDAT/NTDAT,NCWT,NTPR,MSWT(4),NRPT,NHPT,N3PT,NTHP,ASYMT,
     1          NVERT,SWLET(20,4),SWTET(20,4),YTH(20,4),THETAL(400)
      COMMON/THKPAN/XRFT(400),XLFT(400),XRBT(400),XLBT(400),
     1          YRCT(400),YLCT(400),ZRFT(400),ZLFT(400),ZRBT(400),
     2          ZLBT(400),SLLET(400),SLTET(400)
      LOGICAL LEFT
      DATA DTOR/.0174532925/
C
C     FORMAT STATEMENTS
C
  700 FORMAT(1H1,30X,40HPANEL CORNER COORDINATES FOR WING PANELS)
  705 FORMAT(//5X,1HJ,15X,2HLF,15X,1H*,12X,2HLB,15X,1H*,12X,2HRF,15X,
     1          1H*,12X,2HRB/12X,1HX,9X,1HY,9X,1HZ,5X,1H*,3X,1HX,9X,1HY,
     2          9X,1HZ,5X,1H*,3X,1HX,9X,1HY,9X,1HZ,5X,1H*,3X,1HX,9X,1HY,
     3          9X,1HZ,/38X,1H*,29X,1H*,29X,1H*/130(1H*)/
     4          38X,1H*,29X,1H*,29X,1H*)
  710 FORMAT(/1X,56(1H=),17HRIGHT WING PANELS,57(1H=)/)
  711 FORMAT(/1X,57(1H=),16HLEFT WING PANELS,57(1H=)/)
  712 FORMAT(/1X,56(1H=),17HUPPER WING PANELS,57(1H=)/)
  713 FORMAT(/1X,56(1H=),17HLOWER WING PANELS,57(1H=)/)
  720 FORMAT(3X,I3,3X,F9.4,1X,F9.4,1X,F9.4,1H*,F9.4,1X,F9.4,1X,F9.4,
     1          1H*,F9.4,1X,F9.4,1X,F9.4,1H*,F9.4,1X,F9.4,1X,F9.4)
C
C     VERTICAL WING COORDINATES ARE CALCULATED IN THE SAME WAY
C          AS HORIZONTAL COORDINATES.  Y AND Z COORDINATES ARE
C          THEN INTERCHANGED FOR VERTICAL WING.
C          LEFT STANDS FOR EITHER LEFT HORIZONTAL WING
C          OR LOWER VERTICAL WING.
C
      LEFT=IL.EQ.1.OR.IL.EQ.3
      NS=IL+1
      NDP(1)=NRPT
      NDP(2)=NHPT
      NDP(3)=N3PT
      MSWP=MSWT(NS)+1
C
C     SET CONSTANT SWEEP INDICATOR.
C
      LVSWT=0
      IF(MSWP.EQ.2) GO TO 15
      DO 10 I=3,MSWP
      IM=I-1
   10 IF(SWLET(I,NS).NE.SWLET(IM,NS).OR.SWTET(I,NS).NE.SWTET(IM,NS))
     1    LVSWT=1
   15 SLPWLE=TAN(SWLET(MSWP,NS)*DTOR)
      SLPWTE=TAN(SWTET(MSWP,NS)*DTOR)
      CSIDEP=CRP
      ANCW=NCWT
      WLEX=0.0
C
C     LAY OUT PANELS.  INDEX I RUNS SPANWISE, K CHORDWISE.
C
C          CALCULATE OUTBOARD SIDE EDGE FOR A CHORDWISE ROW.
C
      DO 60 I=2,MSWP
      IM=I-1
      IF(LVSWT.EQ.0) GO TO 20
```

```
      SLPWLE=TAN(SWLET(I,NS)*DTOR)
      SLPWTE=TAN(SWTET(I,NS)*DTOR)
   20 SLPDIF=SLPWLE-SLPWTE
      CSIDE=CSIDEP-(YTH(I,NS)-YTH(IM,NS))*SLPDIF
      IF(I.EQ.2) GO TO 30
      JLE=(I-3)*NCWT+1
      IF(NS.GT.1) JLE=JLE+NDP(NS-1)
      WLEX=XRFT(JLE)
      IF(LEFT) WLEX=XLFT(JLE)
   30 CONTINUE
C
C     CALCULATE PANEL LEADING AND TRAILING EDGE
C          SLOPES AND CORNER COORDINATES.
C
      DO 50 K=1,NCWT
      J=(I-2)*NCWT+K
      IF(NS.GT.1) J=J+NDP(NS-1)
      AKM=K-1
      AK=K
      SLLET(J)=SLPWLE-AKM*SLPDIF/ANCW
      SLTET(J)=SLPWLE-AK*SLPDIF/ANCW
      IF (ABS(SLLET(J)).LE.0.001) SLLET(J)=0.0
      IF (ABS(SLTET(J)).LE.0.001) SLTET(J)=0.0
      XLFT(J)=AKM*CSIDEP/ANCW+WLEX
      XLBT(J)=XLFT(J)+CSIDEP/ANCW
      XRFT(J)=AKM*CSIDE/ANCW+(YTH(I,NS)-YTH(IM,NS))*SLPWLE+WLEX
      XRBT(J)=XRFT(J)+CSIDE/ANCW
      YLCT(J)=YTH(IM,NS)
      YRCT(J)=YTH(I,NS)
      IF(.NOT.LEFT) GO TO 40
C
C     INTERCHANGE LEFT AND RIGHT COORDINATES FOR LEFT WING.
C
      TEMP=XLFT(J)
      XLFT(J)=XRFT(J)
      XRFT(J)=TEMP
      TEMP=XLBT(J)
      XLBT(J)=XRBT(J)
      XRBT(J)=TEMP
      TEMP=YLCT(J)
      YLCT(J)=YRCT(J)
      YRCT(J)=TEMP
      IF (SLLET(J).EQ.0.0) SLLET(J)=-TLRNC
      IF (SLTET(J).EQ.0.0) SLTET(J)=-TLRNC
C
   40 CONTINUE
      ZLFT(J)=0.0
      ZRFT(J)=0.0
      ZLBT(J)=0.0
      ZRBT(J)=0.0
C
C     INTERCHANGE Y AND Z COORDINATES FOR VERTICAL PANELS.
C
      IF(NS.LE.2) GO TO 50
      ZLFT(J)=YLCT(J)
      ZLBT(J)=YLCT(J)
      YLCT(J)=0.0
      ZRFT(J)=YRCT(J)
      ZRBT(J)=YRCT(J)
      YRCT(J)=0.0
C
   50 CONTINUE
      CSIDEP=CSIDE
```

```
   60 CONTINUE
C
C     DEBUG PRINT OF PANEL CORNER COORDINATES.
C
      IF(NTPR.EQ.0) RETURN
      IF(IL.GT.0) GO TO 70
      WRITE(6,700)
      WRITE(6,705)
      WRITE(6,710)
      NI=1
      NF=NRPT
      GO TO 90
   70 IF(IL.GT.1) GO TO 75
      WRITE(6,711)
      NI=NRPT+1
      NF=NHPT
      GO TO 90
   75 IF(IL.EQ.3) GO TO 80
      WRITE(6,712)
      NI=NHPT+1
      NF=N3PT
      GO TO 90
   80 WRITE(6,713)
      NI=N3PT+1
      NF=NTHP
   90 WRITE(6,720) (J,XLFT(J),YLCT(J),ZLFT(J),XLBT(J),YLCT(J),ZLBT(J),
     1      XRFT(J),YRCT(J),ZRFT(J),XRBT(J),YRCT(J),ZRBT(J),J=NI,NF)
C
      RETURN
      END
```

```
      SUBROUTINE THKOUT
C
C     VERSION: DEMON1
C
C     THIS ROUTINE PRINTS OUT THICKNESS DATA.  AFTER THE
C          THICKNESS SLOPES ARE PRINTED, THEY ARE DIVIDED BY PI.
C
      LOGICAL ASYMT
      COMMON/THKDAT/NTDAT,NCHT,NTPR,MSWT(4),NRPT,NHPT,N3PT,NTHP,ASYMT,
     1     NVERT,SWLET(20,4),SWTET(20,4),YTH(20,4),THETAL(400)
      DATA PI/3.141592654/
C
  600 FORMAT(1H1,30X,56HINPUT VALUES OF THE LOCAL SURFACE SLOPE OF THE T
     1HICKNESS/32X,52HDISTRIBUTION, FOR EACH CHORDWISE ROW THE FIRST VAL
     2UE/37X,41HIS FOR THE PANEL NEAREST THE LEADING EDGE)
  610 FORMAT( //5X,18HRIGHT WING SURFACE/)
  620 FORMAT( //5X,17HLEFT WING SURFACE/)
  630 FORMAT( //5X,18HUPPER WING SURFACE/)
  640 FORMAT( //5X,18HLOWER WING SURFACE/)
  650 FORMAT(11X,3HROW,30X,6HSLOPES)
  660 FORMAT(8X,I5,4X,(/1H+,27X,8F10.5))
  670 FORMAT(1H1,26H WING THICKNESS INPUT DATA///15X,
     1     55HSPANWISE LOCATIONS OF PANEL SIDE EDGES AND SWEEP ANGLES/
     2     20X,27HOF WING SECTION TO THE LEFT,//26X,
     3     29HSPANWISE   LE SWEEP  TE SWEEP/20X,1HI,5X,8HLOCATION/
     4     28X,4HFEET,5X,7HDEGREES,3X,7HDEGREES)
  675 FORMAT(18X,I3,4X,3F10.5)
  680 FORMAT(/16X,I3,36H THICKNESS PANELS ARE TO BE LAID OUT/16X,I3,
     1     20H CHORDWISE ROWS WITH,I3,12H IN EACH ROW)
```

```
C
C     ---------- OUTPUT THICKNESS PANEL GEOMETRY ----------
C
C     HEADING AND RIGHT WING DATA
C
      WRITE(6,670)
      WRITE(6,610)
      NSP=MSWT(1)+1
      WRITE(6,675) (I,YTH(I,1),SWLET(I,1),SWTET(I,1),I=1,NSP)
      WRITE(6,680) NRPT,MSWT(1),NCWT
C
C     LEFT WING DATA IF NON-ZERO SIDESLIP AND WING ALONE.
C
      IF(.NOT.ASYMT) GO TO 2
      WRITE(6,620)
      NSP=MSWT(2)+1
      WRITE(6,675) (I,YTH(I,2),SWLET(I,2),SWTET(I,2),I=1,NSP)
      NLFT=NHPT-NRPT
      WRITE(6,680) NLFT,MSWT(2),NCWT
C
C     UPPER WING DATA IF VERTICAL WINGS PRESENT
C
    2 CONTINUE
      IF(NVERT.EQ.0) GO TO 4
      WRITE(6,630)
      NSP=MSWT(3)+1
      WRITE(6,675) (I,YTH(I,3),SWLET(I,3),SWTET(I,3),I=1,NSP)
      NUPP=N3PT-NHPT
      WRITE(6,680) NUPP,MSWT(3),NCWT
C
C     LOWER WING DATA IF NON-ZERO SIDESLIP AND WING ALONE.
C
      IF(.NOT.ASYMT) GO TO 4
      WRITE(6,640)
      NSP=MSWT(4)+1
      WRITE(6,675) (I,YTH(I,4),SWLET(I,4),SWTET(I,4),I=1,NSP)
      NDP=NTHP-N3PT
      WRITE(6,680) NDP,MSWT(4),NCWT
C
C     ---------- OUTPUT THICKNESS SLOPES ----------
C
    4 CONTINUE
C
C     HEADING AND RIGHT WING DATA
C
      WRITE(6,600)
      WRITE(6,610)
      WRITE(6,650)
      MN=0
      I=0
      DO 5 JNW=1,NRPT,NCWT
      MN=MN+NCWT
      I=I+1
      WRITE(6,660) I,(THETAL(J),J=JNW,MN)
    5 CONTINUE
C
C     LEFT WING DATA IF NON-ZERO SIDESLIP AND WING ALONE
C
      IF(.NOT.ASYMT) GO TO 20
      WRITE(6,620)
      WRITE(6,650)
      I=0
      NRPP=NRPT+1
```

```
      DO 10 JNW=NRPP,NHPT,NCWT
      MN=MN+NCWT
      I=I+1
      WRITE(6,660) I,(THETAL(J),J=JNW,MN)
   10 CONTINUE
C
C     UPPER WING DATA IF VERTICAL WINGS PRESENT
C
   20 CONTINUE
      IF(NVERT.EQ.0) GO TO 40
      WRITE(6,630)
      WRITE(6,650)
      I=0
      NHPP=NHPT+1
      DO 25 JNW=NHPP,N3PT,NCWT
      MN=MN+NCWT
      I=I+1
      WRITE(6,660) I,(THETAL(J),J=JNW,MN)
   25 CONTINUE
C
C     LOWER WING DATA IF NON-ZERO SIDESLIP AND WING ALONE.
C
      IF(.NOT. ASYMT) GO TO 40
      WRITE(6,640)
      WRITE(6,650)
      I=0
      N3PP=N3PT+1
      DO 30 JNW=N3PP,NTHP,NCWT
      MN=MN+NCWT
      I=I+1
      WRITE(6,660) I,(THETAL(J),J=JNW,MN)
   30 CONTINUE
C
C     DIVIDE INPUT SLOPES BY PI
C
   40 CONTINUE
      DO 45 J=1,NTHP
   45 THETAL(J)=THETAL(J)/PI
C
      RETURN
      END
```

```
      SUBROUTINE THKVEL(XX,YY,ZZ)
C
C
C     VERSION: DEMON1
C
C     THIS SUBROUTINE CALCULATES PERTURBATION VELOCITIES INDUCED BY
C     THE WING THICKNESS PANELS.
C     SUPERPOSITION OF 4 CORNER SOLUTIONS IS USED.
C     THKVEL RETURNS VELOCITIES UTH,VTH,WTH IN WING
C     REFERENCE FRAME.
C
      LOGICAL NOPR,SDSLIP,VERPNL
C
      COMMON/THKDAT/NTDAT,NCWT,NTPR,MSWT(4),NRPT,NHPT,N3PT,NTHP,SDSLIP,
     1       NVERT,SWLET(20,4),SWTET(20,4),YTH(20,4),THETAL(400)
      COMMON/THKPAN/XRFT(400),XLFT(400),XRBT(400),XLBT(400),
     1       YRCT(400),YLCT(400),ZRFT(400),ZLFT(400),ZRBT(400),
     2       ZLBT(400),SLLET(400),SLTET(400)
```

```
      COMMON/ICVEL/UPT,VPT,WPT,IIT,IFT,MJ
      COMMON/THVARG/X,Y,Z,U,V,W,EM ,VERPNL,NOPR
C
    1 FORMAT(5X,5HPANEL,I4,6X,6HCORNER,I2,
     1                          6X,4HC.P.,I5,3X,4HX = ,E12.5,3X,4HY = ,E12.5
     1 ,3X,4HZ = E12.5/6X,4HU = ,E12.5,6X,4HV = ,F12.5,6X,4HW = ,E12.5/
     2  5X,5HTU = ,E12.5,5X,5HTV = ,E12.5,5X,5HTW = ,E12.5)
    2 FORMAT(///6H UPT =,E12.5,5X,5HVTP =,E12.5,5X,5HWPT =,E12.5)
C
      NOPR=NTPR.NE.0
C
      UPT=0.0
      VPT=0.0
      WPT=0.0
      XI=XX
      YI=YY
      ZI=ZZ
C
C     I IS INDEX OF INFLUENCING PANEL
C
      DO 100 I=IIT,IFT
      VERPNL=I.GT.NHPT
      MI=I
      TU=0.
      TV=0.
      TW=0.
      EM1=SLLET(I)
      EM2=SLTET(I)
C
C********************   CORNER 1   ****************************************
C
C
      IF(EM1.LT.0.0) GO TO 15
      EM=EM1
      X=XI-XLFT(I)
      Y=YI-YLCT(I)
      Z=ZI-ZLFT(I)
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW+W
      ICNR=1
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(SDSLIP) GO TO 10
      IF (VERPNL) GO TO 31
      Y=-(YI+YLCT(I))
      CALL VELOTH
      TU=TU+U
      TV=TV-V
      TW=TW+W
      GO TO 32
   31 Z=-(ZI+ZLFT(I))
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW-W
   32 CONTINUE
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 10
C
C     CORNER 1 FOR M .LT.0.0
```

```
C
   15 CONTINUE
      EM=-EM1
      X=XI-XLFT(I)
      Y=YLCT(I)-YI
      Z=ZI-ZLFT(I)
      IF(VERPNL) GO TO 51
      CALL VELOTH
      TU=TU-U
      TV=TV+V
      TW=TW-W
      GO TO 52
   51 Y=-Y
      Z=-Z
      CALL VELOTH
      TU=TU-U
      TV=TV-V
      TW=TW+W
   52 CONTINUE
      ICNR=1
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(SDSLIP) GO TO 17
      IF(VERPNL) GO TO 41
      Y=YLCT(I)+YI
      CALL VELOTH
      TU=TU-U
      TV=TV-V
      TW=TW-W
      GO TO 42
C
   41 Z=ZLFT(I)+ZI
      CALL VELOTH
      TU=TU-U
      TV=TV-V
      TW=TW-W
   42 CONTINUE
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 17
   10 CONTINUE
C
C********************  CORNER 2  *****************************************
C
      X=XI-XRFT(I)
      Y=YI-YRCT(I)
      Z=ZI-ZRFT(I)
      CALL VELOTH
      TU=TU-U
      TV=TV-V
      TW=TW-W
      ICNR=2
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(SDSLIP) GO TO 20
      IF (VERPNL) GO TO 33
      Y=-(YI+YRCT(I))
      CALL VELOTH
      TU=TU-U
      TV=TV+V
      TW=TW-W
      GO TO 34
   33 Z=-(ZI+ZRFT(I))
      CALL VELOTH
```

```
      TU=TU-U
      TV=TV-V
      TW=TW+W
   34 CONTINUE
      MNJ=-MJ
      IF(NOPR)       WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 20
C
C     CORNER 2 FOR M .LT. 0
C
   17 CONTINUE
      X=XI-XRFT(I)
      Y=YRCT(I)-YI
      Z=ZI-ZRFT(I)
      IF(VERPNL) GO TO 53
      CALL VELOTH
      TU=TU+U
      TV=TV-V
      TW=TW+W
      GO TO 54
   53 Y=-Y
      Z=-Z
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW-W
   54 CONTINUE
      ICNR=2
      MNJ=MJ
      IF(NOPR)       WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(SDSLIP) GO TO 20
      IF(VERPNL) GO TO 43
      Y=YRCT(I)+YI
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW+W
      GO TO 44
   43 Z=ZRFT(I)+ZI
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW+W
   44 CONTINUE
      MNJ=-MJ
      IF(NOPR)       WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
   20 CONTINUE
C
C*********************  CORNER 3  *****************************************
C
      IF(EM2.LT.0.0) GO TO 19
      EM=EM2
      X=XI-XLBT(I)
      Y=YI-YLCT(I)
      Z=ZI-ZLBT(I)
      CALL VELOTH
      TU=TU-U
      TV=TV-V
      TW=TW-W
      ICNR=3
      MNJ=MJ
      IF(NOPR)       WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(SDSLIP) GO TO 30
```

```
      IF (VERPNL) GO TO 35
      Y=-(YI+YLCT(I))
      CALL VELOTH
      TU=TU-U
      TV=TV+V
      TW=TW-W
      GO TO 36
   35 Z=-(ZI+ZLBT(I))
      CALL VELOTH
      TU=TU-U
      TV=TV-V
      TW=TW+W
   36 CONTINUE
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 30
C
C     CORNER 3 FOR M .LT. 0
C
   19 CONTINUE
      EM=-EM2
      X=XI-XLBT(I)
      Y=YLCT(I)-YI
      Z=ZI-ZLBT(I)
      IF (VERPNL) GO TO 55
      CALL VELOTH
      TU=TU+U
      TV=TV-V
      TW=TW+W
      GO TO 56
   55 Y=-Y
      Z=-Z
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW-W
   56 CONTINUE
      ICNR=3
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(SDSLIP) GO TO 21
      IF(VERPNL) GO TO 45
      Y=YLCT(I)+YI
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW+W
      GO TO 46
   45 Z=ZLBT(I)+ZI
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW+W
   46 CONTINUE
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 21
   30 CONTINUE
C
C********************  CORNER 4  ****************************************
C
      X=XI-XRBT(I)
      Y=YI-YRCT(I)
      Z=ZI-ZRBT(
```

```
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW+W
      ICNR=4
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(SDSLIP) GO TO 40
      IF (VERPNL) GO TO 37
      Y=-(YI+YRCT(I))
      CALL VELOTH
      TU=TU+U
      TV=TV-V
      TW=TW+W
      GO TO 38
   37 Z=-(ZI+ZRBT(I))
      CALL VELOTH
      TU=TU+U
      TV=TV+V
      TW=TW-W
   38 CONTINUE
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 40
C
C     CORNER 4 FOR M.LT.0
C
   21 CONTINUE
      X=XI-XRBT(I)
      Y=YRCT(I)-YI
      Z=ZI-ZRBT(I)
      IF(VERPNL) GO TO 57
      CALL VELOTH
      TU=TU-U
      TV=TV+V
      TW=TW-W
      GO TO 58
   57 Y=-Y
      Z=-Z
      CALL VELOTH
      TU=TU-U
      TV=TV-V
      TW=TW+W
   58 CONTINUE
      ICNR=4
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(SDSLIP) GO TO 40
      IF(VERPNL) GO TO 47
      Y=YI+YRCT(I)
      CALL VELOTH
      TU=TU-U
      TV=TV-V
      TW=TW-W
      GO TO 48
   47 Z=ZRBT(I)+ZI
      CALL VELOTH
      TU=TU-U
      TV=TV-V
      TW=TW-W
```

```
 48 CONTINUE
    MNJ=-MJ
    IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
 40 CONTINUE
C
    UPT=UPT+TU*THETAL(I)
    VPT=VPT+TV*THETAL(I)
    WPT=WPT+TW*THETAL(I)
100 CONTINUE
C
    IF(NOPR) WRITE(6,2) UPT,VPT,WPT
C
    RETURN
    END


    SUBROUTINE TRBIPW(YI,ZI,YO,ZO,I)
C
C     VERSION: DEMON1
C
C     THIS SUBROUTINE TRANSFORMS COORDINATES AND VELOCITIES FROM WING
C     COORDINATE SYSTEM TO INTERFERENCE PANEL COORDINATE SYSTEM AND
C     VICE VERSA.
C
      LOGICAL ASYM,BODY,DELTA,NOSYM
C
      COMMON/ONE/DUM1(5500),SNT(125),CST(125),SNT2(125),CST2(125),
     1IP(300),XFBIP(100),DUM2(12),DX,DUM3(2),RB,DUM4(12),WBIP,DUM5(11),
     2NBIP,DUM6(10),NPANLS,NPRESS,NWBP,ASYM,BODY,DELTA,NOSYM
C
      DIMENSION YLC(250),ZLF(250)
      EQUIVALENCE (YLC(1),DUM1(4001)),   (ZLF(1),DUM1(4501))
C
C     TRANSFORM FROM BIP TO WING COORDINATES
C
      INP=I+NPANLS
      YO=YI*CST2(I) + ZI*SNT2(I) + YLC(INP)
      ZO=ZI*CST2(I) - YI*SNT2(I) + ZLF(INP)
      RETURN
C
C     TRANSFORM FROM WING TO BIP COORDINATES
C
      ENTRY TRWBIP
      INP=I+NPANLS
      ZC=ZI-ZLF(INP)
      YC=YI-YLC(INP)
   10 YO=YC*CST2(I) - ZC*SNT2(I)
      ZO=ZC*CST2(I) + YC*SNT2(I)
      RETURN
C
C     VELOCITY TRANSFORM -- BIP TO WING
C
      ENTRY ROTBW
      YO=YI*CST2(I) + ZI*SNT2(I)
      ZO=ZI*CST2(I) - YI*SNT2(I)
      RETURN
C
C     WING TO BIP VELOCITY TRANSFORM
C
      ENTRY ROTWB
      ZC=ZI
      YC=YI
```

```
      GO TO 10
      END
```

```
      SUBROUTINE VELCAL(NDIM,ALPHA,BETA,NSTART)
C
C     VERSION: DEMON1
C
C SUBROUTINE TO CALCULATE THE VELOCITIES FOR THE FIELD POINTS X,Y,Z DUE
C TO THE BODY SINGULARITIES.
C
C
      DIMENSION X(150),YY(150),ZZ(150)
C
      LOGICAL ASYM,BODY,DELTA,NOSYM
C
      COMMON/ONE/CIRC(250),DUM1(500),PNLC(250),DUM2(500),VNNOR(250),
     1XBAR(250),ZBAR(250),DUMB(750),         DUM3(2500),DUM4(904),
     2B2,B2V,DUM5(5),CN,DUM6(24),MSWR,MSWL,MSWU,MSWD,DUM7(2),NCW,NDRAG,
     3NBP,NPR,NRP,N3P,DUM8(6),ASYM,BODY,DELTA,NOSYM
      COMMON/TWO/TX(101),DUM9(505),DUMZZ(403),T(100),TC(100),COEFF(5),
     1BCODE,BETASQ,BSQ,RADIUS,RFIELD,RNOSE,U,V,VT,XA,XB,XC,XD,XFIELD,X2,
     2LBODY,NXBODY
      COMMON/BVEL/U1(150),V1(150),W1(150),XFLDP(150),YFLDP(150),
     1 ZFLDP(150)
      COMMON/WBTR/THTI(125),XWLE
C
C
      REAL LBODY
      INTEGER BCODE
C
C
C     TRANSFORM X-COORDINATES INTO THE BODY SYSTEM
C
      DO 50 K=NSTART,NDIM
      X(K)=XFLDP(K)+XWLE
      YY(K)=YFLDP(K)
   50 ZZ(K)=ZFLDP(K)
      N=NXBODY-1
C
C CALCULATION OF COORDINATE ROTATION ANGLE.
C
      IF (ABS(ALPHA).LT.1.0E-04) GO TO 51
      PHI=ATAN(BETA/ALPHA)
      GO TO 52
   51 PHI=0.0
   52 CONTINUE
C
C CALCULATION OF VELOCITIES.
C
C
C  NOTE: FOR A ROLLED CONFIGURATION,ANGLE THPLPH EQUALS ROLL ANGLE PHI
C   PLUS ANGLE THETA(ZB TO YB) ASSOCIATED WITH THE BODY COORDINATE
C   SYSTEM.
C
      DO 100 I=NSTART,NDIM
C
C
      XFIELD=X(I)
      RFIELD=SQRT(YY(I)**2+ZZ(I)**2)
      THETA=ATAN2(YY(I),ZZ(I))
      THPLPH=THETA+PHI
```

```
      RSQ=BETASQ*RFIELD*RFIELD
      X2=XFIELD-LBODY
C
      US=0.
      VS=0.
      UD=0.
      VD=0.
      VTD=0.
      DO 110 J=1,N
      CALL SOURCE(J)
      US=US+T(J)*U
      VS=VS+T(J)*V
      CALL DOUELT(J)
      UD=UD+U*TC(J)
      VD=VD+V*TC(J)
  110 VTD=VTD+VT*TC(J)
C
C TRANSFORMATION OF VELOCITIES INTO BODY COORDINATE SYSTEM.
C U,V,W, RATHER THAN U,VR,VTHETA.
C
      COSTH=COS(THPLPH)
      U1(I)=US+UD*COSTH
      VR=VD*COSTH+VS
      VTD=VTD*SIN(THPLPH)
      SINTH=SIN(THETA)
C
C  AT THIS STAGE U1,VR,VTD ARE THE LONGITUDINAL,RADIAL AND TANGENTIAL
C  VELOCITY COMPONENTS IN THE BODY CYLINDRICAL COORDINATE SYSTEM.
C  NEXT,TRANSFORM INTO RECTANGULAR BODY COODINATE SYSTEM.
C
      COSTH=COS(THETA)
      V1(I)=VR*SINTH+VTD*COSTH
      W1(I)=VR*COSTH-VTD*SINTH
      IF (ABS(U1(I)).LT.1.0E-06) U1(I)=0.0
      IF (ABS(V1(I)).LT.1.0E-06) V1(I)=0.0
      IF (ABS(W1(I)).LT.1.0E-06) W1(I)=0.0
  100 CONTINUE
      RETURN
      END


      SUBROUTINE VELNOR(XX,YY,ZZ)
C
C     VERSION1 DEMON1
C
C     THIS SUBROUTINE CALCULATES PERTURBATION VELOCITIES INDUCED BY
C     THE WING AND BODY INTERFERENCE PANELS USING SUPERPOSITION SCHEME
C     SUPERPOSITION OF 4 CORNER SOLUTIONS IS USED
C     VELNOR RETURNS VELOCITIES UP,VP,WP IN WING REFERENCE FRAME...
C
      LOGICAL ASYM,ASYM1,DELTA,BODY,NOSYM,IGTNP,NOPR
C
      COMMON/ONE/CIRC(250),DELTP(250),FN(250),PNLC(250),SWPPLE(250),
     1SWPPTE(250),DUM1(1000),YCPT(250),ZCPT(250),XLF(250),XLB(250),
     2XRF(250),XRB(250),YLC(250),YRC(250),ZLF(250),ZRF(250),ZLB(250),
     3ZRB(250),SNT(125),CST(125),DUM2(550),
     $                       XFRIP(100),A,ALFA,ALFR,ARWING,B2,B2V,BETA,
     4BETAR,CONST,COSALF,COSBET,CN,DX,EM,FMACH,RB,SINALF,SINBET,SLOPE,
     5TLRNC,TIPY,TOTLR,U,V,W,UP,VP,WP,WBIP,X,Y,Z,MI,IF,II,MJ,MSWR,MSWL,
     6MSWU,MSWD,MSIP,NCRX,NCW,NDRAG,NHP,NPR,NRP,NSP,NOCPT,NOLINP,NOUT,
     7NPANLS,NPRESS,NWBP,ASYM1,BODY,DELTA,NOSYM
C
```

```
      COMMON/WHTR/THTI(125),XWLE
      COMMON /INTRDT/ PHIDIH,THETIT,YBOD,ZBOD,PHIFR,PHIFU
C
      DATA PI/3.141592653590/
C
    1 FORMAT(5X,5HPANEL,I4,6X,6HCORNER,I2,
     1                            6X,4HC.P.,I5,3X,4HX = ,E12.5,3X,4HY = ,E12.5
     1 ,3X,4HZ = E12.5/6X,4HU = ,E12.5,6X,4HV = ,E12.5,6X,4HW = ,E12.5/
     2  5X,5HTU = ,E12.5,5X,5HTV = ,E12.5,5X,5HTW = ,E12.5)
    2 FORMAT(1X,7HASYM = ,L3)
C
      ASYM= NOSYM
      NOPR= (NPR.NE.0)
      DTOR=PI/180.0
C
      UP=0.
      VP=0.
      WP=0.
      XI=XX
      YI=YY
      ZI=ZZ
C
C     I IS INDEX OF INFLUENCING PANEL
C
      DO 100 I=II,IF
      IGTNP= I.GT.NPANLS
      K=I-NPANLS
      MI=I
      TU=0.
      TV=0.
      TW=0.
      EM1=SWPPLE(I)
      EM2=SWPPTE(I)
C
C********************  CORNER 1  *****************************************
C
C
C
C     IF INFLUENCER IS A BODY INTERFERENCE PANEL,SUPERPOSITION IS
C     PERFORMED IN THE WING SYSTEM , SAME FOR INTERDIGITATED FINS.
C     NOTE: BODY INTERFERENCE PANELS IN 2ND. AND 4TH. QUARTERS ACT LIKE
C     WING PANELS WITH NEGATIVE SWEEP
C
      IF (I.LE.NPANLS) GO TO 60
      IF                ((THTI(K).GT.90.0.AND.THTI(K).LE.180.0).OR.
     1(THTI(K).GT.270.0.AND.THTI(K).LE.360.0)) GO TO 15
   60 CONTINUE
      IF (I.LE.NHP) PHIF=PHIFR*DTOR
      IF (I.GT.NHP.AND.I.LE.NPANLS) PHIF=PHIFU*DTOR
      IF (EM1.LT.0.0) GO TO 15
      SLOPE=EM1
      EM=EM1
      X=XI-XLF(I)
      YT=YI-YLC(I)
      ZT=ZI-ZLF(I)
      IF (ABS(X).LE.TLRNC) X=0.0
      IF (ABS(YT).LE.TLRNC) YT=0.0
      IF (ABS(ZT).LE.TLRNC) ZT=0.0
      YW=YT
      ZW=ZT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
C
C     FOR PANELS WITH POSITIVE SWEEP,SUPERPOSITION IS CORNER 1-2-3+4.
```

```
C
C     IF INFLUENCER IS A BODY INFLUENCING PANEL, TRANSFORM WING Y,Z
C     COORDINATES INTO BIP COORDINATE SYSTEM,ONLY NEED TO ROTATE SINCE
C     ORIGIN IS ALREADY AT BIP CORNER
C     THEN TRANSFORM VELOCITIES FROM BIP FRAME BACK TO WING,SAME FOR
C     INTERDIGITATED FINS.
C
      IF (IGTNP) CALL ROTWB(YW,ZW,Y,Z,K)
      CALL VELO
      VB=V
      WB=W
      VT=V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU+U
      TV=TV+V
      TW=TW+W
      ICNR=1
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(NOPR)      WRITE(6,2) ASYM
      IF(ASYM) GO TO 10
      YT=-(YI+YLC(I))
      YW=YT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP) CALL ROTWB(YW,ZW,Y,Z,K)
      CALL VELO
      VB=V
      WB=W
      VT=V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU+U
      TV=TV-V
      TW=TW+W
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 10
C
C
C     FOR PANELS WITH NEGATIVE SWEEP,SUPERPOSITION IS CORNER -1+2+3-4
C
C     CORNER 1 FOR M .LT.0.0
C
   15 CONTINUE
      SLOPE=-EM1
      EM=-EM1
      X=XI-XLE(I)
      YT=YI-YLC(I)
      ZT=ZI-ZLE(I)
      IF (ABS(X).LE.TLRNC) X=0.0
      IF (ABS(YT).LE.TLRNC) YT=0.0
      IF (ABS(ZT).LE.TLRNC) ZT=0.0
      YW=YT
      ZW=ZT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP)  CALL ROTWB(YW,ZW,Y,Z,K)
      Y=-Y
      CALL VELO
      VT=-V
      WT=W
```

```
      VB=-V
      WB=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU-U
      TV=TV-V
      TW=TW-W
      ICNR=1
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(ASYM) GO TO 17
      YT=-(YI+YLC(I))
      YW=YT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP)  CALL ROTWB(YW,ZW,Y,Z,K)
      Y=-Y
      CALL VELO
      VT=-V
      WT=W
      VB=-V
      WB=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU-U
      TV=TV+V
      TW=TW-W
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 17
   10 CONTINUE
C
C********************  CORNER 2  ****************************************
C
      X=XI-XRF(I)
      YT=YI-YRC(I)
      ZT=ZI-ZRF(I)
      IF (ABS(X).LE.TLRNC) X=0.0
      IF (ABS(YT).LE.TLRNC) YT=0.0
      IF (ABS(ZT).LE.TLRNC) ZT=0.0
      YW=YT
      ZW=ZT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP) CALL ROTWB(YW,ZW,Y,Z,K)
      CALL VELO
      VB=V
      WB=W
      VT=V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU-U
      TV=TV-V
      TW=TW-W
      ICNR=2
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(ASYM) GO TO 20
      YT=-(YI+YRC(I))
      YW=YT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP) CALL ROTWB(YW,ZW,Y,Z,K)
      CALL VELO
      VB=V
```

```
      WB=W
      VT=V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU-U
      TV=TV+V
      TW=TW-W
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 20
C
C     CORNER 2 FOR M .LT. 0
C
   17 CONTINUE
      X=XI-XRF(I)
      YT=YI-YRC(I)
      ZT=ZI-ZRF(I)
      IF (ABS(X).LE.TLRNC) X=0.0
      IF (ABS(YT).LE.TLRNC) YT=0.0
      IF (ABS(ZT).LE.TLRNC) ZT=0.0
      YW=YT
      ZW=ZT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP)  CALL ROTWB(YW,ZW,Y,Z,K)
      Y=-Y
      CALL VELO
      VT=-V
      WT=W
      VB=-V
      WB=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU+U
      TV=TV+V
      TW=TW+W
      ICNR=2
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(ASYM) GO TO 20
      YT=-(YI+YRC(I))
      YW=YT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP)  CALL ROTWB(YW,ZW,Y,Z,K)
      Y=-Y
      CALL VELO
      VT=-V
      WT=W
      VB=-V
      WB=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU+U
      TV=TV-V
      TW=TW+W
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
   20 CONTINUE
C
C*********************  CORNER 3  *****************************************
C
      IF (I.LE.NPANLS) GO TO 61
      IF             ((THTI(K).GT.90.0.AND.THTI(K).LE.180.0).OR.
```

```
     1(THTI(K).GT.270.0.AND.THTI(K).LE.360.0)) GO TO 19
   61 IF (EM2.LT.0.0) GO TO 19
      EM=EM2
      SLOPE=EM2
      X=XI-XLB(I)
      YT=YI-YLC(I)
      ZT=ZI-ZLB(I)
      YW=YT
      IF (ABS(X).LE.TLRNC) X=0.0
      IF (ABS(YT).LE.TLRNC) YT=0.0
      IF (ABS(ZT).LE.TLRNC) ZT=0.0
      ZW=ZT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP) CALL ROTWB(YW,ZW,Y,Z,K)
      CALL VELO
      VB=V
      WB=W
      VT=V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU-U
      TV=TV-V
      TW=TW-W
      ICNR=3
      MNJ=MJ
      IF(NOPR)     WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(ASYM) GO TO 30
      YT=-(YI+YLC(I))
      YW=YT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP) CALL ROTWB(YW,ZW,Y,Z,K)
      CALL VELO
      VB=V
      WB=W
      VT=V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU-U
      TV=TV+V
      TW=TW-W
      MNJ=-MJ
      IF(NOPR)     WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 30
C
C     CORNER 3 FOR M .LT. 0
C
   19 CONTINUE
      SLOPE=-EM2
      EM=-EM2
      X=XI-XLB(I)
      YT=YI-YLC(I)
      ZT=ZI-ZLB(I)
      IF (ABS(X).LE.TLRNC) X=0.0
      IF (ABS(YT).LE.TLRNC) YT=0.0
      IF (ABS(ZT).LE.TLRNC) ZT=0.0
      YW=YT
      ZW=ZT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP)  CALL ROTWB(YW,ZW,Y,Z,K)
      Y=-Y
      CALL VELO
```

```
      VT=-V
      WT=W
      VB=-V
      WB=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU+U
      TV=TV+V
      TW=TW+W
      ICNR=3
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(ASYM) GO TO 21
      YT=-(YI+YLC(I))
      YW=YT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP)  CALL ROTWB(YW,ZW,Y,Z,K)
      Y=-Y
      CALL VELO
      VB=-V
      WB=W
      VT=-V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU+U
      TV=TV-V
      TW=TW+W
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 21
   30 CONTINUE
C
C********************  CORNER 4  ****************************************
C
      X=XI-XRB(I)
      YT=YI-YRC(I)
      ZT=ZI-ZRB(I)
      IF (ABS(X).LE.TLRNC) X=0.0
      IF (ABS(YT).LE.TLRNC) YT=0.0
      IF (ABS(ZT).LE.TLRNC) ZT=0.0
      YW=YT
      ZW=ZT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP) CALL ROTWB(YW,ZW,Y,Z,K)
      CALL VELO
      VB=V
      WB=W
      VT=V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU+U
      TV=TV+V
      TW=TW+W
      ICNR=4
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(ASYM) GO TO 40
      YT=-(YI+YRC(I))
      YW=YT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP) CALL ROTWB(YW,ZW,Y,Z,K)
      CALL VELO
```

```
      VT=V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU+U
      TV=TV-V
      TW=TW+W
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      GO TO 40
C
C     CORNER 4 FOR M.LT.0
C
   21 CONTINUE
      X=XI-XRB(I)
      YT=YI-YRC(I)
      ZT=ZI-ZRB(I)
      IF (ABS(X).LE.TLRNC) X=0.0
      IF (ABS(YT).LE.TLRNC) YT=0.0
      IF (ABS(ZT).LE.TLRNC) ZT=0.0
      YW=YT
      ZW=ZT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP)  CALL ROTWB(YW,ZW,Y,Z,K)
      Y=-Y
      CALL VELO
      VT=-V
      WT=W
      VB=-V
      WB=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU-U
      TV=TV-V
      TW=TW-W
      ICNR=4
      MNJ=MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
      IF(ASYM) GO TO 40
      YT=-(YI+YRC(I))
      YW=YT
      IF (.NOT.IGTNP) CALL ROTWF(YT,ZT,Y,Z,PHIF)
      IF (IGTNP)  CALL ROTWB(YW,ZW,Y,Z,K)
      Y=-Y
      CALL VELO
      VB=-V
      WB=W
      VT=-V
      WT=W
      IF (.NOT.IGTNP) CALL ROTFW(VT,WT,V,W,PHIF)
      IF (IGTNP) CALL ROTBW(VB,WB,V,W,K)
      TU=TU-U
      TV=TV+V
      TW=TW-W
      MNJ=-MJ
      IF(NOPR)      WRITE(6,1) MI,ICNR,MNJ,X,Y,Z,U,V,W,TU,TV,TW
   40 CONTINUE
C
      IF(II.EQ.IF.AND.NOCPT.EQ.0) GO TO 101
      UP=UP+TU*DELTP(I)
      VP=VP+TV*DELTP(I)
      WP=WP+TW*DELTP(I)
  100 CONTINUE
```

```
      UP=UP/CONST
      VP=VP/CONST
      WP=WP/CONST
      RETURN
C
C     UP,VP,WP BELOW ARE FOR SETTING UP INFLUENCE FUNCTIONS FOR USE IN
C     THE INFLUENCE MATRIX
C
  101 UP=TU
      VP=TV
      WP=TW
      RETURN
      END


      SUBROUTINE VELO
C
C     VERSION:DEMON2.
C
C     THIS SUBROUTINE CALCULATES THE INFLUENCE OF THE BASIC
C     SEMI-INFINITE TRIANGLES WHICH ARE UNDER CONSTANT LOADING.
C     MORE CORRECTLY, THEY ARE UNDER CONSTANT U DIFFERENCE
C     THE COORDINATE SYSTEM USED HERE IS THE COORDINATE SYSTEM ASSO-
C     CIATED WITH THE TRIANGLE UNDER CONSIDERATION.
C
      LOGICAL ASYM,BODY,DELTA,NOSYM
C
      COMMON/ONE/DUM1(6400),A,DUM2(5),BETA,DUM3(6),EM,DUM4(4),SLOPE,
     1TLRNC,TIPY,TOTLR,U,V,W,DUM5(4),X,YS,ZS,MI,DUM6(2),MJ,DUM7(8),NHP,
     2NPR,DUM8(2),NOCPT,NOLINP,NOUT,NPANLS,DUM9(2),ASYM,BODY,DELTA,NOSYM
C
      NAMELIST /DEBUG/X,Y,Z,F1,F2,    F4,F5,    F7,ARG,  EML,BETA,U,V,W
     1,TOP,BOT,ARGY,      TLRNC,YEDGE
C
      DATA PI/3.14159265359/
C
C
C     STATEMENT FUNCTIONS.
C     PLANAR FORMULATION
C
      F1T(X,Y,Z) = Z*SQRT(XSQ-BTSQ*(YSQ+ZSQ))
      F1B(X,Y,Z) = Y*(EML*Y-X)+EML*ZSQ
      FF2(X,Y,Z) = EML*ALOG((X*EML-BTSQ*Y
     1  + SQRT((X*EML-BTSQ*Y)*(X*EML-BTSQ*Y)
     2  - BTSQ*((Y*EML-X)*(Y*EML-X)+ EMLSQ*ZSQ-BTSQ*ZSQ)))
     4  /(BETA*SQRT((Y*EML-X)*(Y*EML-X) + EMLSQ*ZSQ-BTSQ*ZSQ)))
     6  / SQRT(ABS(EMLSQ-BTSQ))
      FF4(X,Y,Z) = (Y/(YSQ+ZSQ))*SQRT(XSQ-BTSQ*(YSQ+ZSQ))
      FF5(X,Y,Z) = ALOG((X+SQRT(XSQ-BTSQ*(YSQ+ZSQ)))
     1  /(BETA*SQRT(YSQ+ZSQ)))
      FF7(X,Y,Z) = (Z/(YSQ+ZSQ))*SQRT(XSQ-BTSQ*(YSQ+ZSQ))
      FFSON(X,Y,Z) = (SQRT(XSQ-BTSQ*(YSQ+ZSQ)))/(X-BETA*Y)
      FSS(X,Y,Z) = EML*ATAN2(SQRT((BTSQ-EMLSQ)*(XSQ-BTSQ*(YSQ+ZSQ))),
     1    X*EML-BTSQ*Y)  / SQRT(ABS(EMLSQ-BTSQ))
C
C
      Y=YS
      Z=ZS
      TOP=0.0
      BOT=0.0
```

```
      EML=EM
      XSQ=X*X
      YSQ=Y*Y
      ZSQ=Z*Z
      BTSQ=BETA*BETA
      EMLSQ=EML*EML
C
C     CHECK FOR SUBSONIC,SONIC OR SUPERSONIC LEADING EDGE
C
      IF (X.LT.0.0) GO TO 50
      IF (X.EQ.0.0.AND.Y.EQ.0.0.AND.Z.EQ.0.0) GO TO 50
      IF(ABS(EML).LT.(100.0*TLRNC)) GO TO 120
      YEDGE=X/EML
      GO TO 121
  120 YEDGE=10.0E+07
      GO TO 20
C
C     CHECK FOR SUBSONIC,SONIC, OR SUPERSONIC LEADING EDGE
C
  121 ARG=BTSQ*(1./EMLSQ)
      IF (ABS(ARG-1.0).LT.TLRNC) GO TO 25
      IF(ARG.LT.1.0) GO TO 10
      RBT=SQRT(YSQ+ZSQ)*BETA
      IF(X.GT.RBT) GO TO 63
      GO TO 21
   50 U=0.
      V=0.
      W=0.
      RETURN
C
C     SUPERSONIC LEADING EDGE CASE --
C
   20 CONTINUE
C
C     CHECK IF POINT (X,Y,Z) LIES INSIDE, ON, OR OUTSIDE MACH CONE
C     FROM ORIGIN
C
      RBT=SQRT(YSQ+ZSQ)*BETA
      IF(X.GT.RBT) GO TO 24
   21 IF(Y.LT.0.0.OR.Y.GE.YEDGE) GO TO 50
C
C     POINT LIES OUTSIDE MACH CONE FROM ORIGIN BUT THE POINT LIES
C     INSIDE MACH CONE FROM LEADING EDGE AT SAME Y AS P(X,Y,Z)
C
      YC=X*EML/BTSQ
      IF (Y.LT.YC) GO TO 50
      XLE=Y*SLOPE
      XTRNSF=X-XLE
      IF (ABS(XTRNSF).LE.(100.0*TLRNC)) XTRNSF=0.0
      ZCONE=XTRNSF/(SQRT(BTSQ-EMLSQ))
      IF (ABS(Z).GT.ZCONE) GO TO 50
      IF(ABS(Z)    .LT.TLRNC.OR.(Z)    .GT.0.) GO TO 70
      GO TO 71
   70 F1=PI
      GO TO 74
   71 F1=-PI
   74 F2=-(EML*PI)/SQRT(ABS(BTSQ-EMLSQ))
      IF (ABS(EML).LT.(100.0*TLRNC)) F2=-BETA*PI
      IF (XTRNSF.EQ.0.0.AND.Z.EQ.0.0) F2=F2/2.0
      F4= 0.0
      F5=0.
      F7=0.0
      GO TO 47
C
```

```
C     POINT LIES INSIDE MACH CONE FROM ORIGIN
C
   24 CONTINUE
      F2=-BETA*ATAN2(SQRT(X*X-BTSQ*(YSQ+ZSQ)),-BETA*Y)
      GO TO 22
   63 F2=-FSS(X,Y,Z)
      GO TO 22
C
C     SONIC LEADING EDGE CASE--
C
   25 CONTINUE
C
C     CHECK IF POINT(X,Y,Z) LIES ON OR OUTSIDE MACH CONE FROM ORIGIN
C     IF TRUE SET PERTURBATION VELOCITIES EQUAL TO ZERO
C
      RBT=SQRT(YSQ+ZSQ)*BETA
      IF (X.LE.RBT) GO TO 50
      F2=-FFSON(X,Y,Z)
      XTRNSF=X-XLE
      IF (XTRNSF.EQ.0.0.AND.Z.EQ.0.0) F2=F2/2.0
      GO TO 22
C
C     SUBSONIC LEADING EDGE CASE--
C
   10 CONTINUE
C
C     CHECK IF POINT (X,Y,Z) LIES ON OR OUTSIDE MACH CONE
C     IF TRUE SET PERTURBATION VELOCITIES TO ZERO
C
      RBT=SQRT(YSQ+ZSQ)*BETA
      IF(X.LE.RBT) GO TO 50
      ARG2=BETA*SQRT((Y*EML-X)*(Y*EML-X)+EMLSQ*ZSQ-BTSQ*ZSQ)
      IF (ABS(ARG2).LT.TLRNC) GO TO 26
      F2=FF2(X,Y,Z)
      GO TO 22
   26 F2=0.0
   22 CONTINUE
      IF (Y.EQ.0.0.AND.Z.EQ.0.0) GO TO 50
      ARGY=Y-YEDGE
      IF(ABS(ARGY).LT.(100.0*TLRNC).AND.ABS(Z).LT.TLRNC) GO TO 50
      TOP=F1T(X,Y,Z)
      BOT=F1B(X,Y,Z)
      IF(ABS(TOP).GE.TLRNC) GO TO 43
      IF (Y.GT.0.0.AND.Y.LT.YEDGE.AND.ABS(Z)    .LT.TLRNC) GO TO 48
      GO TO 44
   48 F1=PI
      GO TO 46
   43 F1=ATAN2(TOP,BOT)
      IF(ABS(F1).LT.TLRNC) F1= 0.
      GO TO 46
   44 F1=0.0
   46 CONTINUE
      F4= FF4(X,Y,Z)
      F5=FF5(X,Y,Z)
      F7=FF7(X,Y,Z)
C
C     CALCULATE PERTURBATION VELOCITIES U/V,V/V,W/V
C
   47 U=F1
      IF(ABS(EML).LT.(100.0*TLRNC)) GO TO 101
      V=-EML*F1+F7
      W=        (EML*(ABS (1.0-BTSQ/EMLSQ)*F2-F5)-F4)
      GO TO 102
```

```
  101 CONTINUE
      V= F7
      W=-F4+F2
  102 CONTINUE
C
      IF (NPR.NE.0) WRITE (6,DEBUG)
C
      RETURN
      END
```

```
      SUBROUTINE VELOTH
C
C     VERSION: DEMON1
C
C     THIS SUBROUTINE CALCULATES THE INFLUENCE OF A SEMI-INFINITE
C     TRIANGLE WITH  CONSTANT SOURCE STRENGTH.
C
      LOGICAL VERPNL,INSIDE,NOPR
C
      COMMON/THVARG/XTH,YTH,ZTH,UTH,VTH,WTH,EML,VERPNL,NOPR
      COMMON/THVFLO/BETA,TLRNC,BTSQ
C
      NAMELIST/DEBUG/X,Y,Z,EML,INSIDE,ARG1,BETA,F1,F2,F5,
     1        UTH,VTH,WTH,YEDGE,ARGY
      DATA PI/3.14159265/
C
C     SET VELOCITIES TO ZERO FOR WHATEVER REASON
C
      IF(XTH.GE.TLRNC) GO TO 3
    1 UTH=0.0
      VTH=0.0
      WTH=0.0
      RETURN
C
C     CHECK IF THE INFLUENCING PANEL IS A VERTICAL PANEL.
C     IF SO, Y=ZTH AND Z=-YTH
C     THI TRANSFORMATION ROTATES SEMI INFINITE TRIANGLE 90 DEG. IN
C     COUNTERCLOCKWISE DIRECTION.
C
    3 CONTINUE
      X=XTH
      IF(VERPNL) GO TO 4
      Y=YTH
      Z=ZTH
      GO TO 5
    4 Y=ZTH
      Z=-YTH
    5 YSQ=Y*Y
      ZSQ=Z*Z
      EMLSQ=EML*EML
      ARG1=X*X-BTSQ*(YSQ+ZSQ)
      INSIDE=ARG1 .GT. TLRNC
C
C     CHECK FOR SPECIAL CASE OF UNSWEPT LEADING EDGE
C
      IF(ABS(EML).LT.(100.0*TLRNC)) GO TO 70
      YEDGE=X/EML
      ARGY=Y-YEDGE
C
C     CHECK WHETHER LEADING EDGE IS SUBSONIC, SONIC, OR SUPERSONIC
```

```
C
      STEST=BTSQ-EMLSQ
      IF(ABS(STEST).LT.TLRNC) GO TO 20
      IF(STEST.GT.0.0) GO TO 30
C
C********** SUBSONIC LEADING EDGE **********
C
C     DETERMINE IF POINT LIES INSIDE OR OUTSIDE MACH CONE FROM ORIGIN
C     IF IT LIES OUTSIDE, SET PERTURBATION VELOCITIES TO ZERO
C
      IF(.NOT.INSIDE) GO TO 1
C
C     POINT LIES INSIDE MACH CONE FROM ORIGIN
C
      RAD=SQRT(ARG1)
      T1=X*EML-BTSQ*Y
      T2=BETA*SQRT((Y*EML-X)*(Y*EML-X)+ZSQ*(EMLSQ-BTSQ))
C
C     TEST FOR POSSIBLE SINGULARITY IN F1 OR F2
C
      IF(ABS(ARGY).LT.(100.0*TLRNC).AND.ABS(Z).LT.TLRNC) GO TO 1
      F2=(EML/SQRT(EMLSQ-BTSQ))*ALOG((T1+SQRT(T1*T1-T2*T2))/T2)
      IF(ABS(Y).LT.TLRNC.AND.ABS(Z).LT.TLRNC) GO TO 13
      F1=ATAN2(Z*RAD,EML*(YSQ+ZSQ)-Y*X)
      F5=ALOG((X+RAD)/(BETA*SQRT(YSQ+ZSQ)) )
      GO TO 100
C
C     CASE FOR Y AND Z BOTH SMALL
C
   13 F1=0.0
      VTH=0.0
      GO TO 101
C
C********** SONIC LEADING EDGE **********
C
   20 IF(.NOT.INSIDE) GO TO 1
      RAD=SQRT(ARG1)
      F2=RAD/(X-BETA*Y)
C
C     F1 AND F5 SAME AS IN SUBSONIC LEADING EDGE
C
      IF (ABS(Y) .LT. TLRNC .AND. ABS(Z) .LT. TLRNC) GO TO 21
      F5=ALOG((X+RAD)/(BETA*SQRT(YSQ+ZSQ)))
      IF(ABS(ARGY).LT.TLRNC.AND.ABS(Z).LT.TLRNC) GO TO 22
      F1=ATAN2(Z*RAD,EML*(YSQ+ZSQ)-Y*X)
      GO TO 100
C
C     Y AND Z BOTH SMALL
C
   21 F1=0.
      VTH = 0.
      GO TO 101
C
C     Z SMALL AND Y CLOSE TO LEADING EDGE
C
   22 F1=0.
      GO TO 100
C
C********** SUPERSONIC LEADING EDGE **********
C
C     DETERMINE WHETHER POINT LIES INSIDE MACH CONE FROM ORIGIN
C     IF OUTSIDE, THERE IS ONE MORE CHECK TO BE MADE
C
```

```
   30 IF(INSIDE) GO TO 31
C
C     POINT IS OUTSIDE MACH CONE FROM ORIGIN
C     DETERMINE IF IT IS INSIDE MACH CONE FROM LEADING EDGE
C     IF OUTSIDE, SET PERTURBATION VELOCITIES TO ZERO
C
      IF(Y .LT. 0.0 .OR. Y .GE. YEDGE) GO TO 1
      YC=X*EML/BTSQ
      IF (Y.LT.YC) GO TO 1
      XLE=Y*EML
      XTRNSF=X-XLE
      ZCONE=XTRNSF/SQRT(STEST)
      IF (ABS(Z).GT.ABS(ZCONE)) GO TO 1
C
C     POINT IS INSIDE MACH CONE FROM LEADING EDGE
C
      F2= PI*EML/SQRT(BTSQ-EMLSQ)
      F1=PI
      IF(Z.LT.0.0) F1=-PI
      F5=0.0
      GO TO 100
C
C     POINT IS INSIDE MACH CONE FROM ORIGIN
C
   31 T3=SQRT(BTSQ-EMLSQ)
      RAD=SQRT(ARG1)
      F2=(EML/T3)*ATAN2(RAD*T3,X*EML-BTSQ*Y)
C
C     USE F1 AND F5 AS IN SUBSONIC LEADING EDGE CASE
C
      IF (ABS(Y) .LT. TLRNC .AND. ABS(Z) .LT. TLRNC) GO TO 32
      F5=ALOG((X+RAD)/(BETA*SQRT(YSQ+ZSQ)))
      F1=ATAN2(Z*RAD,EML*(YSQ+ZSQ)-Y*X)
      GO TO 100
C
C     Y AND Z BOTH SMALL
C
   32 F1=0.
      VTH=0.
      GO TO 101
C
C
C********** SPECIAL CASE FOR UNSWEPT LEADING EDGE **********
C
C     DETERMINE WHETHER POINT LIES INSIDE MACH CONE FROM ORIGIN
C     IF OUTSIDE, THERE IS ONE MORE CHECK TO BE MADE
C
   70 IF(INSIDE) GO TO 72
C
C     POINT IS OUTSIDE MACH CONE FROM ORIGIN
C     DETERMINE IF IT IS INSIDE MACH CONE FROM LEADING EDGE
C     IF OUTSIDE, SET PERTURBATION VELOCITIES TO ZERO
C
      IF(Y .LT. 0.) GO TO 1
      RSTB=ABS(Z)*BETA
      XTEST=X-RSTB
      IF((RSTB .LT. TLRNC .AND. X.LE.0.).OR.XTEST.LE.TLRNC)GO TO 1
C
C     POINT BETWEEN MACH CONE FROM ORIGIN AND LEADING EDGE
C
      UTH=-PI/BETA
      F1=PI
      IF(Z.LT.0.0) F1=-PI
```

```
      VTH=0.0
      WTH=F1
      GO TO 102
C
C     POINT IS INSIDE MACH CONE FROM ORIGIN
C
   72 RAD=SQRT(ARG1)
      UTH=-ATAN2(RAD,-BETA*Y)/BETA
      F2=0.0
      IF(ABS(Z) .LT. TLRNC .AND. ABS(Y) .LT. TLRNC)GO TO 73
      F1=ATAN2(Z*RAD,-Y*X)
      F5=ALOG((X+RAD)/(BETA*SQRT(YSQ+ZSQ)))
      VTH=-F5
      WTH=F1
      GO TO 102
   73 VTH=0
      WTH=0
      GO TO 102
C
C     COMPUTE PERTURBATION VELOCITIES
C
  100 VTH=F2-F5
  101 UTH=-F2/EML
      WTH=F1
  102 IF(.NOT. VERPNL) GO TO 103
      TEMP=VTH
      VTH=-WTH
      WTH=TEMP
  103 CONTINUE
      IF(NOPR) WRITE(6,DEBUG)
      RETURN
      END


      SUBROUTINE VRTVEL(NSTART,N)
C
C     VERSION: DEMON1
C
C
C     SUBROUTINE FOR CALCULATION OF VELOCITIES INDUCED BY FIXED EXTERNAL
C     VORTICES IN THE PRESENCE OF A CIRCULAR BODY AT FIELDPOINTS
C     WITH COORDINATES XFLDP,YFLDP,ZFLDP.
C
C     THIS SUBROUTINE READS IN UP TO 10 VORTEX STRENGHTS AND THEIR
C     LOCATIONS  IN THE CROSSFLOW PLANE
C     Y IS TO THE RIGHT WHEN VIEWING FORWARDS, Z IS UP
C     VORTEX INDUCED VELOCITIES ARE NAMED VVRTX,WVRTX
C
C
      LOGICAL ASYM,BODY,DELTA,NOSYM
C
C
      COMMON/ONE/CIRC(250),DELTP(250),FN(250),PNLC(250),SWPPLF(250),
     1SWPPTE(250),VNOR(250),XBAR(250),ZBAR(250),XCPT(250),YCPT(250),ZCPT
     2(250),XLF(250),XLB(250),XRF(250),XRB(250),YLC(250),YRC(250),ZLF(25
     30),ZRF(250),ZLB(250),ZRB(250),SNT(125),CST(125),SNT2(125),CST2(125
     4),IP(300),XFBIP(100),A,ALFA,ALFR,ARWING,B2,B2V,BETA,BETAR,CONST,
     5COSALF,COSBET,CN,DX,EM,FMACH,RB,SINALF,SINBET,SLOPE,TLRNC,TIPY,
     6TOTLR,U,V,W,UCHK,VCHK,WCHK,WBIP,X,DUMY,Z,I,IF,II,J,MSWR,MSWL,MSWU,
     7MSWD,NBIP,NCRX,NCW,NDRAG,NHP,NPW,NRP,NSP,NOCPT,NOLINP,NOUT,NPANLS,
     8NPRESS,NWBP,ASYM,BODY,DELTA,NOSYM
```

```
      COMMON/VRTXV/VVRTX(150),WVRTX(150),NVRTPL,NVRTX,VRTMAX
      COMMON/VORSPC/GAMMA(10),YVRTX(10),ZVRTX(10),RLOC
      COMMON/BVEL/DUMB(450),XFLDP(150),YFLDP(150),ZFLDP(150)
C
    1 FORMAT (8F10.5)
    2 FORMAT (1H1,10X,79H2DIM,VORTEX NON-DIMENSIONAL STRENGHTS AND FIXED
     1 COORDINATES IN CROSS LOW PLANE
     1                            //15X,1HI,10X,6HGAMMA/,23X,2HY/,17X,
     22HZ/,/24X,23H(2.0*PI*BODY RAD.*VINF),5X,11H(BODY RAD.),8X,
     311H(BODY RAD.)//)
    3 FORMAT (15X,I2,8X,F10.5,17X,F10.5,9X,F10.5)
C
C      READ IN NON-DIMENSIONALIZED VORTEX STRENGHTS,GAMMA=GAMMA/
C      (2*PI*BODY RADIUS*VINF)
C      AND NON-DIMENSIONALIZED LOCATIONS,YVRTX/BODY RADIUS,
C      ZVRTX/BODY RADIUS
C
      WRITE (6,2)
      DO 100 I=1,NVRTX
      READ (5,1) GAMMA(I),YVRTX(I),ZVRTX(I)
      WRITE (6,3) I,GAMMA(I),YVRTX(I),ZVRTX(I)
  100 CONTINUE
C
C      COMPUTE VORTEX INDUCED PERTURBATION VELOCITIES AT CONTROL POINTS
C      OF ALL WING SURFACES AND BODY INTERFERENCE SHELL.
C      CONTRIBUTION DUE TO EXTERNAL VORTEX....VVRTXE,WVRTXE
C      CONTRIBUTION DUE TO IMAGE    VORTEX....VVRTXI,WVRTXI
C      CONTRIBUTION DUE TO CENTER   VORTEX....VVRTXC,WVRTXC
C   NOTE:***CENTER VORTEX EFFECTS ARE SET ZERO
C
C      ENTER HERE IF VORTICES HAVE BEEN READ IN ALREADY OR CALCULATED IN
C      SUBROUTINE BDYPR.
C
      ENTRY VORTEX
C
      DO 101 IC=NSTART,N
      Y=YFLDP(IC)/RLOC
      YS=Y*Y
      Z=ZFLDP(IC)/RLOC
      ZS=Z*Z
      DENOM=YS+ZS
      DO 102 JV=1,NVRTX
      ZVSYVS=ZVRTX(JV)*ZVRTX(JV)+YVRTX(JV)*YVRTX(JV)
      DELTY=Y-YVRTX(JV)
      DELTYS=DELTY*DELTY
      DELTZ=Z-ZVRTX(JV)
      DELTZS=DELTZ*DELTZ
      DENOM1=DELTYS+DELTZS
      IF ((DENOM1).LE.TLRNC) GO TO 105
      VVRTXE=-GAMMA(JV)*(DELTZ/DENOM1)
      WVRTXE= GAMMA(JV)*(DELTY/DENOM1)
      GO TO 106
  105 VVRTXE=0.
      WVRTXE=0.
  106 CONTINUE
      DENOM2=(Y-YVRTX(JV)/ZVSYVS)**2+(Z-ZVRTX(JV)/ZVSYVS)**2
      IF (ABS(DENOM2).LE.TLRNC) GO TO 107
      VVRTXI=GAMMA(JV)*(Z-ZVRTX(JV)/ZVSYVS)/DENOM2
      WVRTXI=-GAMMA(JV)*(Y-YVRTX(JV)/ZVSYVS)/DENOM2
      GO TO 108
  107 VVRTXI=0.0
      WVRTXI=0.0
  108 CONTINUE
```

```
      VVRTXC=0.0
      WVRTXC=0.0
      VVRTX(IC)=VVRTX(IC)+VVRTXE+VVRTXI+VVRTXC
      WVRTX(IC)=WVRTX(IC)+WVRTXE+WVRTXI+WVRTXC
C
C     LIMIT MAGNITUDE OF PERTURBATION VELOCITIES TO VRTMAX.
C
      IF (VVRTX(IC).GT.0.0.AND. ABS(VVRTX(IC)).GE.VRTMAX) VVRTX(IC)=
     1  VRTMAX
      IF (VVRTX(IC).LT.0.0.AND. ABS(VVRTX(IC)).GE.VRTMAX) VVRTX(IC)=
     1 -VRTMAX
      IF (WVRTX(IC).GT.0.0.AND. ABS(WVRTX(IC)).GE.VRTMAX) WVRTX(IC)=
     1  VRTMAX
      IF (WVRTX(IC).LT.0.0.AND. ABS(WVRTX(IC)).GE.VRTMAX) WVRTX(IC)=
     1 -VRTMAX
  102 CONTINUE
  101 CONTINUE
C
      RETURN
      END
```

```
      SUBROUTINE VVELS(NV,YY,ZZ,VX,VY,G,AB,BB,V,W,VRTMAX)
C
C     VERSION: DEMON1
C
C     THIS SUBROUTINE COMPUTES PERTURBATION VELOCITY COMPONENTS DUE TO
C     NV EXTERNAL VORTICES AND THEIR IMAGES INSIDE A BODY WITH
C     ELLIPTICAL CROSS SECTION. THEY ARE ADDED TO V AND W IN THE
C     ARGUMENT LIST.
C
C
      DIMENSION VX(1),VY(1),G(1)
C
      COMMON/COM1/A2,B2,R2
      COMMON/COM2/SIG2,H2
C
      COMPLEX TO,V1,DSDT,Z,DSDZ,SI,SIB,SO,TAU,CI,VEL
C
      EXTERNAL Z,DSDZ
      PI=3.14159265
      TLC=0.001
      CI=CMPLX(0.0,1.0)
      A2=AB*AB
      B2=BB*BB
      APB=AB+BB
      APB2=APB*APB
      R=0.5*APB
      H2=APB2
      R2=R*R
      SIG2=R2
      TO=CMPLX(YY,ZZ)
      SO=Z(TO)
      V1=CMPLX(0.0,0.0)
      DSDT=DSDZ(SO)
C
C   LOOP OVER THE NUMBER OF VORTICES,NV
C
      DO 1 I=1,NV
      TAU=CMPLX(VX(I),VY(I))
```

```
      SI=Z(TAU)
      SIB=CONJG(SI)
      D=CABS(SI-SO)
      IF(D.LE.TLC) GO TO 2
      V1=V1-G(I)/(SO-SI)
    2 CONTINUE
      D=CABS(SO-R2/SIB)
      IF(D.LE.TLC) GO TO 1
      V1=V1+G(I)/(SO-R2/SIB)
    1 CONTINUE
C
      VEL=0.5*CI*V1*DSDT/PI
      V=REAL(VEL)+V
      W=-AIMAG(VEL)+W
      AV=ABS(V)
      AW=ABS(W)
      IF(V.GT.0.0.AND.AV.GE.VRTMAX) V=VRTMAX
      IF(V.LT.0.0.AND.AV.GE.VRTMAX)V=-VRTMAX
      IF(W.GT.0.0.AND.AW.GE.VRTMAX) W=VRTMAX
      IF(W.LT.0.0.AND.AW.GE.VRTMAX)W=-VRTMAX
      RETURN
      END


      COMPLEX FUNCTION Z(CT)
C     VERSION: DEMON1
C
C     VERSION: DEMON1
C
C     THIS FUNCTION SUBROUTINE CALCULATES THE SIGMA VALUE IN THE
C     TRANSFORMED (CIRCLE) PLANE FOR GIVEN TAU IN THE PHYSICAL PLANE
C     FOR AN ELLIPTICAL BODY WITH WINGS
C
      COMMON/COM2/SIG2,H2
      COMMON/COM3/ZR,ZI
      COMMON/COM4/G2,G1
      COMMON/COM6/W2,W
C
C
      COMPLEX W,G1,G2,CT,W2,DBLU
C
      EXTERNAL DBLU
C
      W=DBLU(CT)
      G1=W+SIG2/W
      G2=G1*G1-H2
      Y=AIMAG(G2)
      AY=1.0
      IF(Y.LT.0.0) AY=-1.0
      YZ=AIMAG(G1)
      AYZ=1.0
      IF(YZ.LT.0.0)AYZ=-1.0
      G2=CSQRT(G2)*AY*AYZ
      IF((ABS(YZ).LE.0.0).AND.(REAL(G1).LT.0.0)) G2=CMPLX(-REAL(G2),
     1      AIMAG(G2))
      Z=0.5*(G1+G2)
      IF((ABS(ZI).NE.0.0).AND.(ABS(ZR).NE.0.0)) Z=CMPLX(ZR*ABS(REAL(Z)),
     1ZI*ABS(AIMAG(Z)))
      RETURN
      END
```

APPENDIX K

DESCRIPTION OF PROGRAM WDYBDY

INTRODUCTION

The purpose of this appendix is to describe the body source paneling program. Attention is given to the program's input, its output, the added special features to account for specified body nose shed vortices, and its interplay with program DEMON2 described in Appendix J. In relation to the work described in this report, program WDYBDY is employed to handle bodies in supersonic flow when they are elliptical in cross section.

Basically, the building blocks of this body modeling program have been extracted from Woodward's improved method described in reference 9 and documented in reference 10. Existing subroutines have been modified to account for combined angle of pitch and sideslip. Subroutines have been added to include effects of specified body nose vorticity in the calculation of pressures on the body.

This program performs the following tasks when the body of the configuration of interest is elliptical in cross section. First, the pressures acting on the forebody are calculated by this program including effects of specified body nose vortices if applicable. Second, the program has been arranged to compute velocity components induced by the body source panels at the control points distributed over the forward set of lifting surfaces (monoplane wing) and the associated body interference shell. If the length of body between the forward and tail lifting surfaces is long enough to influence the overall loads, program WDYBDY should be used to compute the pressure distributions over the afterbody. Effects of body nose and monoplane wing vortices must first be determined by program VPATHL which is described in Appendix L. This program computes the vortex paths along the afterbody. By means of an exchange of data sets with program WDYBDY, vortex induced velocity components are transferred to subroutine PRESS for inclusion in the calculation of pressures at points on the afterbody. Finally, this program calculates the velocity components induced by the body source panels at the control points of the tail lifting surfaces/interdigitated tails.

Thus, program WDYBDY, together with programs DEMON2 and VPATHL, is used repeatedly in accordance with the procedure described in Section 5.2.

In this way, complete configurations involving bodies with elliptical cross section are handled.

The theoretical basis of program WDYBDY and its usage will be summarized. The calculation procedure, program operation, program limitations and termination conditions are described. Special debugging output options are discussed. Detailed descriptions of the program input and output are then given. Program listings appear at the end of this appendix.

PROGRAM DESCRIPTION

A summary of the theory associated with body source panels is given in Section 4. Body source panels are distributed over the body surface as shown in figures 2 and 24. Panel orientation angles δ and θ are indicated in the sketch of Section 4.1. These panels model the body with elliptical cross section in supersonic flow.

Program WDYBDY is an adaptation of the computer program of reference 10. It has been specialized to flow model bodies with elliptic cross section. Body geometry can be specified in terms of the horizontal and vertical semiaxes FUSBY and FUSAZ as a function of axial distance from the body nose XFUS. The configuration can be pitched and rolled giving rise to angles of pitch and sideslip. The boundary condition and pressure equations have been extended to account for angle of sideslip in addition to angle of pitch, see Section 4. The force and moment calculations have also been modified to include angle of sideslip. Normal force and side force, as well as pitching moment and yawing moment are calculated in the body- and wind-axis coordinate systems. The subroutines affected by the changes involving the inclusion of effects of combined angle of pitch and sideslip are SOLVE, PRESS and FORMOM.

In addition, subroutines READVX, ELBDVT and VVELS have been included to read in body nose separation vortex positions and strengths as a function of axial distance and to compute their contributions to the velocity components used in the Bernoulli pressure expression, equation 10. In the latter process, a slender-body theory solution is used. The solution is concerned with the calculation of velocity components induced by a set of vortices at specified points in the presence of a body with elliptical cross section. As such, the solution is a simplified version of the general solution described in Appendix I for the case involving a monoplane wing mounted on a body with elliptical cross section. Subroutine VVELS makes use of function subroutines DBLU, DSDZ and Z. The vortex induced velocity components are computed from expressions implemented in these routines using complex quantities.

A certain amount of graphical display can be generated through the use of routines PLOTG, PLOTA2, PLOTA3, PLOTA5, PLOTA6, PLOTA8 and PLOTV2. This capability serves as an aid in checking the input parameters that govern the geometrical layout of the body source panels. It also allows for an initial look at the pressure distributions on the body.

Calculation Procedure

The program calculations are blocked into four parts, each of which depends on the completion of the previous step but which do not interact with each other. The four major partitions of the calculations are: the generation of panel geometric properties, the calculation of the aerodynamic influence coefficients, the solution for the strengths, pressures and loadings and the calculation of velocities induced at specified set of control points. All data interchanged between these blocks is either saved in common or on external files. The basic program description is contained in reference 10. A flow chart of the subroutine flow sequence is shown in figure K-1.

In the geometry block of routine GEOM, the configuration is read by CONFIG. Body paneling may be computed for a subset of the geometry used to define the configuration. NEWRAD is used to redefine the meridional lines describing the panel side edges and BODPAN both redefines the x-spacing of the panels and computes the panel corner points and inclination angles δ and θ. The geometry description is saved on TAPE 7. If vortices are to be accounted for, the x-location at which vorticity characteristics are given are read from READVX before calling NEWRAD. If the control points are to be saved for use by other programs, a table of panel control points is written on TAPE 4 at the completion of the generation of the geometry.

The generation of the aerodynamic matrix coefficients is organized in VELCMP. The velocity contributions and influences between panels are computed by BODVEL and SORPAN. The aerodynamic matrix and velocities are saved on files TAPE 8, TAPE 9, and TAPE 10.

The solution of the equations and the calculation of pressures and forces is governed by routine SOLVE. The flow tangency boundary condition is defined and the solution of the equations is computed by a combination of routines DIAGIN, PARTIN, ITRATE and INVERT. The contribution to the velocity components from external vortices is included by either interpolation in a vortex strength table or by directly reading the contributions computed by external programs such as program VPATHL described in Appendix L. The pressure coefficient on each panel and the forces and moments acting on the body are then computed in PRESS and FORMOM, respectively. If the integration of the forces and moments over the length of body between specified x-locations XSTART and XWLE is required, the force and moment calculations are repeated for that length of body.

The last calculation block is performed when the calculation of velocity components at specified control points is requested. The velocity components in the body coordinate directions are computed using the solution strengths obtained in the previous part. No contribution due to vorticity is included in this calculation. The velocities are written after the control points on TAPE 4 for transmittal to program DEMON2 described in Appendix J in accordance with the procedures given in Section 5.2.

Program Operation

The body modeling program using source panels on the surface is written in FORTRAN IV language (029 punch) and has been run on a CDC 6600 machine. The program is an adaptation of the wing-body-tail program in reference 10 simplified to body-only modeling. The program is arranged so that a total of 600 source panels are available to cover the body surface. The current version requires 122000 octal core locations to run on the CDC 6600.

The program requires seven disk files for operation. Because of the input copy feature of the program, the normal program input is read from TAPE 5 and not the INPUT tape. The normal input file may not be rewound. TAPE 4 may be used for either of three functions. If NWCPT is greater than one, specified control points are read from TAPE 4, velocities computed and written after the control points on TAPE 4. If NCPOUT is equal to one, the control points associated with the body source panels aft of XSTART and forward of XWLE are written on TAPE 4. If NVLIN is equal to one, the velocity components calculated by program VPATHL for control points aft of XSTART and forward of XWLE are read from TAPE 4. Files TAPE 7, TAPE 8, TAPE 9, and TAPE 10 are used to store intermediate results required for the solution of the aerodynamic matrix.

Programs Limitations

The body modeling program has several limitations due to current code dimensions and due to the limitations inherent to the linear theory. The code will handle up to 600 body source panels during solution. There is a further limitation with regard to the number of panels in a given ring and the total number of rings. The maximum number of panels on the half body for symmetric cases and on the full body for nonsymmetric cases is restricted to 20 panels on a single ring. Similarly, the maximum number of rings of panels in the axial direction is limited to thirty. The flow limitation on the code is that the angle of inclination of all panels be less than the vertex angle of the Mach cone at supersonic speeds. No provisions are incorporated in the program for the presence of detached shocks. A summary of the program termination conditions that are checked for in the code follows. When body nose vortices are present, up to ten vortices may be handled simultaneously. When the calculation of velocities are performed at external field points, a maximum of 600 field point coordinates may be read in at a time.

Program Termination Conditions

A number of labeled STOP conditions exist in the program. These may exist as a result of error conditions or end-of-data checks. They are as follows:

STOP	Routine	Description
STOP 20	GEOM	Normal program termination for end of data on TAPE 5.

STOP	Routine	Description
STOP 200	GEOM	Error - body has more than 20 columns panels around circumference.
STOP 120	NEWRAD	Error - body has more than 20 meridians.
STOP 130	NEWRAD	Error - body has more than 60 axial stations.
STOP 20	BODPAN	Error - number of rows of source panels in section exceeds 30.
STOP 30	BODPAN	Error - number of rows of source panels on body exceeds 30.
STOP 500	PRTCPT	Termination for NCPOUT equals 2.
STOP 210	SORPAN	Panel slope exceeds Mach cone angle.

Supplementary Print from CDUMP

The routine CDUMP was written to provide additional print of variables in common for debugging purposes during execution. It is called at several points within the program as specified by the print controls IPRT. The information is printed according to the value of the option as follows:

Value	Supplementary print
0	Prints only name of routine from which called.
1	Prints variables and arrays of less than 11 in length for common blocks: JOPTNS, PARAM, NEWCOM, VELCOM, and SEG.
2	Prints all of above common blocks.
3	Prints variable array BLOCK in unlabelled common.
4	Prints variables array ARRAY in common block POINT.
5	Prints common block COMPS.
6	Prints common block TRAN.
7	Prints common block BTHET
8	Prints common blocks COEF, MATCOM, and ITERAT.

Note for print control IPRINT = 0, no print is output.

Description of Configuration Geometry Input Cards

The configuration geometry input defines the external shape of the body only. The auxiliary geometry input later defines the sequence to be used in paneling the configuration by interpolation in the external geometry. The input description used here was adapted directly from reference 10 where it is used to describe an entire configuration. In all cases the original definitions have been preserved. For certain options additional meanings have been attached.

WDYBDY Program Input Data

This program was adapted from the body analysis portion of the program detailed in reference 10. Herein, the geometric variables and their definitions used to describe the body have been maintained wherever possible. Several additional cards have been added to the program to facilitate the input of new program options and the description of parameters associated with discrete vortex properties. An additional input file used to exchange control points and velocities is also required. The original description of the cards and documentation in reference 10 has been maintained for simplicity. A sample input deck is described in Section 6.2 and shown in figure 25.

The input to the program consists of four parts: the definition of program options associated with printing, plotting and vortex options; the numerical description of the configuration geometry; an auxiliary data set specifying the singularity paneling scheme and program options; and the case cards defining the Mach number, combined angle of attack and roll, and vortex locations and strengths.

The definition of the coordinate axes used in this program is defined in figure 2. The x_B, y_B and z_B axes in figure 2 correspond to the x_B, y_B, and z_B axes used in program DEMON2 and shown in figure 1. The body is considered to be viewed facing forward with the positive x_B-axis aft, the positive y_B-axis out the right and the positive z_B-axis up. In the following, the B-subscript is omitted wherever the body coordinates are mentioned.

APPENDIX K

Descriptions of Input Option Cards

The options defined here control supplementary output and online plotting not defined by IPRINT and the specification of special control point and vortex options. The latter variables control the additional input to be read in later.

Card 1 - Title card - Card 1 contains any desired identifying information in columns 1-80.

Card 2 - Option Integers - Card 2 contains 14 integers, each punched right justified in a 3-columnar field (14I3). Columns 73-80 may be used in any desired manner. It is designated the IPRT card for reference. Subroutine CDUMP referenced to in the following in connection with print control IRPT is discussed above as part of the program description. Card 2 reads the following:

Column	Variable	Value	Description
1-3	IPRT(1)	0	Do not print copy of input
		1	Print formatted copy of input data
4-6	IPRT(2)	0	No supplementary print after GEOM
		>0	Call CDUMP for special print after GEOM
7-9	IPRT(3)	0	No supplementary print of vortices
		1	Print supplementary information after calculation of vortex velocity components
10-12	IPRT(4)	0	No supplementary print after VELCMP
		>0	Call CDUMP for special print after VELCMP
13-15	IPRT(5)	0	No supplementary print after SOLVE
		>0	Call CDUMP for special print after SOLVE
16-18	IXZSYM	0	Panel only symmetric half of configuration
		1	Panel full configuration symmetrically using geometry of positive y side.
		-1	Panel full configuration by reading geometry of both sides
19-21	IPLOT(1)	0	Do not plot geometry
		1	Plot three orthographic projections and perspective of geometry of panel layout on line printer

Column	Variable	Value	Description
22-24	IPLOT(2)	0	Do not plot CP
		1	Plot CP at each control point versus x location and versus meridional angle θ
25-27	IPLOT(3)	0	Not available
28-30	IPLOT(4)	0	Not available
31-33	NWCPT	0	Do not call BDYVEL. TAPE 4 input is not required
		1-600	NWCPT values of I, XPT, YPT, ZPT control points are read from TAPE 4 and velocities induced by body source panels computed at these coordinates
		-1	NBODY values of XPT, YPT, ZPT control points are generated internally and velocities computed to test routine BDYVEL. TAPE 4 is not used. NBODY is the total number of source panels distributed over the body surface
34-36	NVTX	0	No body nose vortex strengths or Y and Z location data is read. All vortex contributions to velocities are set to zero
		1-10	Vortex Y and Z locations, YVRTX and ZVRTX, and strengths, Γ/V are read for each of NXVTX x-stations, XV. Three cards are read for each vortex
37-39	NXVTX	0	No body nose vortex x-station data is read. All vortex contributions to velocities are set to zero
		1-10	Body nose vortex x-body stations are read. These x values define the stations at which vortex Y, Z and Γ/V data will be read. One XV card is to be read. Maximum number of x-stations is 10
40-42	NCPOUT	0	No control points are output on TAPE 4
		1	X,Y,Z body control points aft of XSTART and forward of XWLE are written in (I5, 3E12.5) format on TAPE 4. Conversely, options specified by NWCPT and NVLIN will not work
		2	Same function as NCPOUT = 1 except program execution is terminated at that point
43-45	NVLIN	0	No vortex velocities are read

Column	Variable	Value	Description
		1	Body source panel control point and V and W data are read for each of the x-stations aft of XSTART and forward of XWLE from TAPE 4 as defined previously for NCPOUT = 1. XCP, YCP, ZCP, VA and WA are read in (I5, 5E12.5) for each of the x-stations. Conversely, options defined by NWCPT and NCPOUT will not work.

Card 3 - Option X-stations - Card 3 contains two real numbers punched in a 7-column field (2F7.0). Columns 73-80 may be used to identify the card. It is designated the XWLE card for reference. Card 3 reads the following:

Column	Variable	Description
1-7	XWLE	x-station of wing root chord leading edge. This variable has two meanings: 1) For NWCPT>0, XWLE is the reference distance from zero of the body axis coordinate system to the reference zero of the lifting surfaces whose control points are to be read from TAPE 4. It is added to the x-values read for the control points. 2) For NCPOUT = 1 or NVLIN=1, XWLE is the aft boundary of control points to be output or read in. It would correspond to the leading edge of the wing or tail surface root chord
8-14	XSTART	x-station of start of region of additional velocity influence. For NCPOUT=1 or NVLIN=1, XSTART is the forward boundary of control points for which additional velocity components are computed or read in and control points calculated

Note: The special force calculation computes the loadings acting on the body panels with control points between x-locations XSTART and XWLE. For this calculation to be valid between these values, the user should also make the x-locations of appropriate panel leading or trailing edges correspond to the XSTART and XWLE locations as prescribed on the XFUSK card.

The geometry of the configuration may either be symmetrical or non-symmetrical about the y-0 plane (the plane of symmetry). The original configuration definition, which allowed only the description of symmetric configurations, may be used to define only one side of the configuration or to define a paneling sequence for both sides. The input of both sides of the geometry is also allowed. The convention used in this program for definition of a symmetric configuration is to present that half of the configuration located on the positive y side of the y=0 plane. The number of input cards depends on the number of segments and the amount of detail used to describe each component. In connection with the work described in this report, disregard all references to wings, tails, and pods.

Card 4 - Control integers - Card 4 contains 24 integers, each punched right justified in a 3-column field. Columns 73-80 may be used in any desired manner. It is designated the JCARD in the data deck for reference. Card 4 contains the following:

Column	Variable	Value	Description
1-3	J0	0	No reference area
		1	Reference area to be read in
4-6	J1	0	Wing data option - not available
7-9	J2	0	No fuselage data
		1	Data for arbitrarily shaped fuselage to be read
		-1	Data for circular fuselage in form of cross sectional areas versus XFUS to be read
		-2	Data for circular fuselage in form of radii versus XFUS to be read
		-3	Data for elliptic fuselage in form of semi-axis in y-direction and semi-axis in z-direction to be read (With J6=0, fuselage will be cambered. With J6= -1, fuselage will be symmetrical with xy-plane. With J6=1, entire configuration will be symmetrical with y=0 plane.)
10-12	J3	0	Pod data option - not available
13-15	J4	0	Fin data option - not available
16-18	J5	0	Canard (horizontal tail) option - not available
19-21	J6	0	A cambered circular or arbitrary fuselage if J2 is nonzero. Read ZFUS data cards (described later under fuselage data cards)

Column	Variable	Value	Description
		1	Complete configuration is symmetrical with respect to xy-plane, which implies an uncambered circular fuselage
		-1	Uncambered circular fuselage with J2 nonzero
22-24	NWAF	0	Number of airfoil sections - not available
25-27	NWAFOR	0	Number of airfoil ordinates - not available
28-30	NFUS	1-4	Number of fuselage segments
31-33	NRADX(1)	3-30	Number of points used to represent the first fuselage segment about the circumference. If the configuration is symmetric (IXZSYM=0,1) NRADX is input for the half section. If the entire configuration is input (IXZSYM= -1) NRADX is input for the full section. If fuselage is circular, the program computes the indicated number of y- and z-ordinates
34-36	NFORX(1)	2-30	Number of x-stations for first fuselage segment
34-39	NRADX(2)	3-30	Same as NRADX(1), but for second fuselage sement
40-42	NFORX(2)	2-30	Same as NFORX(1), but for second fuselage segment
43-45	NRADX(3)	3-30	Same as NRADX(1), but for third fuselage segment
46-48	NFORX(3)	2-30	Same as NFORX(1), but for third fuselage segment
49-51	NRADX(4)	3-30	Same as NRADX(1), but for fourth fuselage segment
52-54	NFORX(4)	2-30	Same as NFORX(1), but for fourth fuselage segment
55-57	NP	0	Number of pods - not available
58-60	NPODOR	0	Number of pod stations - not available
61-63	NF	0	Number of fins - not available
64-66	NFINOR	0	Number of fin ordinates - not available
67-69	NCAN	0	Number of canards - not available
70-72	NCANOR	0	Number of canard ordinates - not available

Card 5,6,... - remaining input data cards - The remaining input data cards contain a detailed description of the body component configuration. Each card contains up to 10 values, each value punched in a 7-column field with a decimal point (10F7.0 format) and may be identified in columns 73-80. The cards are arranged in the following order as required by the above options: reference area card and fuselage data cards.

Reference area card: The reference area value is punched in columns 1-7 and may be identified as REFA in columns 73-80.

Fuselage data cards: The first card (or cards) specifies the x-values of the fuselage stations of the first segment. There will be NFORX(1) values and the cards may be identified in columns 73-80 by the symbols XFUSJ where J denotes the number of the last fuselage station given on that card. If the fuselage is cambered (J2<0, and J6=0) the z-values of the fuselage centerline are read next. There will be NFORX(1) values of z at the above x-stations.

If the fuselage is circular or elliptical, the next card (or cards) is specified according to option J2. If J2= -1, the card contains NFORX(1) values of fuselage cross-sectional areas and may be identified in columns 73-80 by the symbol FUSARDJ where J denotes the number of the last fuselage stations given on that card. If J2= -2, the card contains NFORX(1) values of fuselage section radii, and may be identified in columns 73-80 by the symbol FUSRADJ. If J2= -3, two cards (or sets of cards) containing the elliptic body horizontal and vertical semi-axes are given. The first is the horizontal semi-axis and is designated by the symbol FUSBYJ. The second contains NFORX(1) values of the vertical semi-axis and is designated by the symbol FUSAZJ.

If the fuselage is of arbitrary shape, NRAD(1) values of the y-ordinates for a half section are given and identified in columns 73-80 as YJ where J is the station number. Following the y-ordinates are the NRADX(1) values of the corresponding z-ordinates for the half-section (or full section for IXZSYM= -1) identified in columns 73-80 as ZJ. Each station will have a set of y and z, and the convention of ordering the ordinates from bottom to top is observed. If the full section is given, the ordering continues from the top back to and including the bottom point to close the section.

For each fuselage segment a new set of cards as described must be provided. The segment descriptions should be given in the order of increasing values of x.

Description of Auxiliary Input Cards

Card 1 - Identification - Card 1 contains any desired identifying information in columns 1-80.

Card 2 - Boundary condition and control point definition - The specification of the lifting-surface boundary conditions are not applicable in the body alone version. This card also selects the output print options as originally described in reference 10. This card contains the following:

Column	Variable	Value	Description
1-3	LINBC	0	Planar boundary condition - not available
4-6	THICK	0	Thickness option - not available
7-9	IPRINT	0	Print out the pressures and the forces and moments
		1	Print out option 0 and spanwise loads on the wing, fins, and canards
		2	Print out option 1 and the velocity components and source and vortex strengths
		3	Print out option 2 and the steps in the iterative solution
		4	Print out option 3 and the axial and normal velocity matrices

A negative value of print adds the panel geometry print out to the output indicated for options 1 through 4.

LINBC, THICK, and IPRINT are punched as right justified integers.

Card 3 - Revised configuration paneling description control integers - The contents of card 2 are punched as right justified integers as follows:

Column	Variable	Value	Description
1-3	K0	0	No reference lengths
		1	Reference length data to be read

Column	Variable	Value	Description
4-6	K1	0	No wing data - not available
7-9	K2	0	No body data
		1	Body data follows
10-12	K3		Not used
13-15	K4	0	No fin (vertical tail) data - not available
16-18	K5	0	No canard (horizontal tail) data - not available
19-21	K6		Not used
22-24	KWAF	0	Number of wing sections - not available
25-27	KWAFOR	0	Number of wing ordinates - not available
28-30	KFUS		The number of fuselage segments. The program sets KFUS = NFUS
31-33	KRADX(1)	0, 3-20	Number of meridian lines used to define panel edges on first body segment. There are three options for defining the panel edges. If KRADX(1) = 0, the merdian lines are defined by NRADX(1) in the geometry input. If KRADX(1) is positive, the meridian lines are calculated at KRADX(1) equally spaced PHIKs. If KRADX(1) is negative, the meridian lines are calculated at specified values of PHIK. For symmetric configurations (IXZSYM=0,1), KRADX is the number of meridians on the half-section. For full configurations (IXZSYM=1), KRADX is the number of meridians on the full section including meridians at 0° and 360°
34-36	KFORX(1)	0, 2-30	Number of axial stations used to define leading and trailing edges of panels on first body segment. If KFORX(1) = 0, the panel edges are defined by NFORX(1) in the geometry input
37-39	KRADX(2)	0, 3-20	Same as KRADX(1), but for second body segment
40-42	KFORX(2)	0, 2-30	Same as KFORX(1), but for second body segment
43-45	KRADX(3)	0, 3-20	Same as KRADX(1), but for third body segment
46-48	KFORX(3)	0, 2-30	Same as KFORX(1), but for third body segment

Column	Variable	Value	Description
49-51	KRADX(4)	0, 3-20	Same as KRADX(1), but for fourth body segment
52-54	KFORX(4)	0, 2-30	Same as KFORX(1), but for fourth body segment

The program is restricted to 600 body singularity panels. For this program there is an additional restriction that the total number of singularity panels in the axial direction on the body (fuselage) cannot exceed 30. The arbitrary body (fuselage) capability of this program is limited to those shapes for which the radius is a single-valued function of PHIK for each cross section of the body.

Card 4,5,... - remaining input data cards - The remaining input data cards contain a detailed description of the singularity paneling of each component of the configuration. Each card contains up to 10 values, each value punched in a 7-column field with a decimal point (10F7.0 format) and may be identified in columns 73-80. The cards are arranged in the following order as required by the above options: reference lengths, vortex x-station card, and fuselage (body) data cards.

Reference length card: This card may be identified as REFL in columns 73-80 and contains the following:

Column	Variable	Description
1-7	REFA	Wing reference area. If REFA = 0, the reference area is defined by the value of REFA in the geometry input
8-14	REFB	Wing semispan - not used
15-21	REFC	Wing reference chord - not used
22-28	REFD	Body (fuselage) reference diameter. If REFD = 0, a value of 1.0 is used for the reference diameter. This reference length is used to non-dimensionalize all moment coefficients
29-35	REFL	Body (fuselage) reference length. If REFL = 0, a value of 1.0 is used for the reference length
36-42	REFX	x coordinate of moment center
43-49	REFZ	z coordinate of moment center

Vortex x-station card: This card is read if NXVTX is greater than zero. It is identified in columns 73-80 by the symbol XV. This card contains NXVTX values (maximum is 10) of the x-stations at which vortex strength and location will be input later, XV. These locations constitute the table in which the strength of the vortices will be obtained for each control point on the body in order to compute the cross flow solutions due to the presence of discrete vortices. The first and last x-values in this table also constitute boundaries between which vortex solutions will be computed. Outside of this range of x-stations, the contribution of the vortices will be set to zero. The values XV are punched in up to ten 7-column fields (10F7.0 format). The interpolation is currently limited by dimensions to 10 values of XV.

Fuselage (body) data cards: If KRADX(1) is negative, the first body card is the body meridian angle card. This card contains KRADX(1) values of body meridian angle expressed in degrees and may be identified in columns 73-80 as PHIKJ where J denotes the body segment number. The convention is observed that PHIK = 0, is at the bottom of the body and PHIK = 180, is at the top of the body. Repeat this card for each fuselage segment.

If KFORX(1) is non-zero, the second body card is the body axial station card. This card contains KFORX(1) values of the x-ordinate of the body axial stations and may be identified in columns 73-80 as XFUSKJ where J denotes the body segment number. Repeat this card for each fuselage segment. If forces and moments are to be integrated between values of XSTART and XWLE, the panel boundaries specified in XFUSK should correspond to one or both of these values where appropriate.

If either of these cards are omitted, the program generates the values internally from the previous configuration definition.

Description of case control cards

<u>Card 1 - Mach number and angle of attack card</u> - This card may be identified in columns 73-80 as MALPHA and contains the following in three 7-column fields:

Column	Variable	Description
1-7	MACH	The subsonic Mach number (including the value MACH = 0.) or the supersonic MACH number at which it is desired to calculate the aerodynamic data
8-14	ALPHAC	Included angle of attack at which it is desired to calculate the aerodynamic data, measured in degrees between the free-stream velocity vector and the body centerline
15-21	PHIR	Angle of roll, measured in degrees from the plane containing the free-stream velocity vector and the body centerline (the z-axis) positive clockwise

A value of MACH = -1 on this card signifies the termination of the present case. Geometry cards for a new case can follow such a terminal card.

Card 2,3,4... - Vortex strength and locations cards - If NVTX is greater than one, three cards are read for each of NVTX number of vortices. Each of the cards contains up to ten values punched in 7-column fields (10F7.0 format).

The first vortex card contains the y-location of the vortex at each of the x-stations on the XV card. There are NXVTX values on the card which is designated by the symbol YVRTXI where I is the vortex number in columns 73-80.

The second vortex card contains the z-location of the vortex at each of the x-stations on the XV card. There are NXVTX values on the card which is designated by the symbol ZVRTXI where I is the vortex number in columns 73-80.

The third vortex card contains the vortex strength divided by free stream velocity, Γ/V, of the vortex at each of the x-stations on the XV card. There are NXVTX values on the card which is designated by the symbol GAMI where I is the vortex number in columns 73-80.

A series of Mach number, angle of attack, and vortex card combinations for the same geometry may be calculated by repeating this sequence of case control cards with the desired values. If the case control sequence has been terminated by MACH = -1 on the MALPHA card an attempt to read a new set of geometry will be made. The program will terminate if no cards exist by testing for the end of file.

Description of Output

This section describes the minimum output for the body source panel program, WDYBDY. This output occurs when IPRINT = -3 and IPRT(1)=1 in the input. All primary output items are summarized here. The outputs associated with source panel properties is described in detail in reference 10 and will only be mentioned here. A sample is given in connection with the description of the second calculative example, Section 6.2 and figure 26. For general reference the subroutine names from which the print was made is written starting in column 110 between two asterisks for the first occurrence of print within a routine. Wherever possible these identifications will be used in specifying the output to be described.

The first page of output is the list of the input cards copied directly from TAPE 5, on which it is stored, as card images. The input is rewound after copying to the output file (TAPE 6), and read again by the program as needed.

The next two (or more pages) are a copy of the input data with its mnemonic name or function as it is read from the input. The output is in the following order: the run title and option summary read in GEOM, the vehicle geometry cards as read by CONFIG, and the paneling title card and options as read by GEOM. If NXVTX>0, routine READVX prints a summary of body x-stations (XV) as read from input and the horizontal and vertical semi-axes of an elliptic section at those stations (BY and AZ). The horizontal and vertical axes are computed by interpolation in the program input geometr.

The next page is a summary of the body panel corner point coordinates as generated in BODPAN. The x,y,z coordinates of each corner point of each panel is printed. The next page is a summary of the x, y, and z coordinates of the body source panel centroids. The next page is a summary of the body panel areas and inclination angles in radian and degrees. The angle DELTA is the inclination of the source panel to the body x-axis and the angle THETA is the angle between the leading edge of the panel and the body y-axis. These angle are indicated in the shock of Section 4.1. Additional output may be obtained for debugging purposes at the end of the geometry calculations as specified by the print options IPRT(2) and IPLOT(1).

The output from VELCMP is printed next summarizing the aerodynamic velocity matrix computations. The normal output is a summary of the numbers of panels and the CPU time required for the calculation of the velocity matrix coefficients. Output of the coefficients may be obtained from IPRINT=$\pm$4. If the number of panels exceeds sixty, the solution vector is printed for intermediate iterations.

After the aerodynamic matrix has been computed a new case is begun from WDYBDY. This consists of the solution for the source strengths for a given Mach number, angle of attack, α_c, and angle of roll, ϕ. If the Mach number changes between cases, the program goes back to recompute the aerodynamic matrix.

The output from ELBDVT, concerned with body nose vorticity, is given next. A copy of the input y and z locations and the vortex strength, Γ/V, is printed first for the I'th vortex. This print is controlled by the option IPRT(1). A vortex interpolation table summarizing the strengths and locations of each of the discrete vortices to be used by VVELS in the computation of velocities induced by the nose separation vortices. The vortex trajectory is defined by XV, YVRTX, and ZVRTX for an elliptic body with horizontal and vertical semi-axes, BY and AZ. An additional debug output may be obtained for IPRT(3)=1 which summarizes the vortex properties at each of the control points as the velocities are computed.

The next page of output is printed from SOLVE summarizing the velocities on the body. For each of the panels the source strength, GB, and the axial, lateral and vertical velocity components, u, v, w, and the resultant inward normal, NB, due to only the source strength are given. In addition the velocity contributions due to discrete external vortices in the lateral and vertical directions, VA and WA, are printed. All velocity components are assumed to be positive in their respective positive coordinate directions. The sum of the contributions of the velocities due to source panels and discrete vortices is used in the calculation of pressures.

The next page of output is printed from FORMOM. It contains a summary of the forces on the panels due to the pressure acting on each of the panels. At each control point with coordinates X, Y, Z, and polar angle, THETP, measured positive counterclockwise from the positive y-axis, the pressure coefficient, CP, and the panel forces, CX, CY, and CZ acting along the body coordinate axes, and the moments of these forces about the reference center about each of the axes, CLL, CM, and CLN, are given. The pressure coefficient, CP, has a minimum value corresponding to zero static pressure, equation 11. The sense of the axial force, CX, is positive acting aft on the body; the force CY is positive acting to the right; and the force CZ is positive acting up. The pitching moment, CM, is positive nose up about the y-axis; the yawing moment, CLN, is positive nose right viewing downwards about the z-axis; and the rolling moment, CLL, is positive clockwise viewing forwards about the x-axis.

The total coefficients on the body are printed on the next page. These are the sum of the force components of the individual panels described above. The forces in the body coordinate system, CX, CY, and CZ are normalized bv the reference area, REFA. The moments, CM, CLN, and CLL, have been normalized by the product of the reference area and the reference diameter, REFD. The moments are taken about the center, (REFX, 0, REFZ). The x-location of the center of pressure, XCP, is printed as computed from the ratio, -CM/CZ. The force and moment coefficients are also specified in the wind axis system, see Section 4.2.

If distinct values of XSTART and XWLE have been specified the next two pages are a repeat of the previous two pages with the difference that only the forces and moments between XSTART and XWLE are computed. The total force coefficients are then the sum of the forces acting on panels between the above two variables. The program only checks on the location of control points within the x-range specified. For the integration to be valid the user must make the leading edges of the first ring of panels inside the range correspond to XSTART and the trailing edges of the last ring of panels in the range must correspond to XWLE. This is necessary since only the integration over whole panels is within the current capability of the program.

APPENDIX K

The next page is printed when NWCPT≠0. It is a summary of the calculation of velocity components at specified field points. If NWCPT>0, the field points are read from TAPE 4 as created by program DEMON2. If NWCPT<0, the control points for panels generated within WDYBDY are used. In this case the velocities should reproduce the results first printed in SOLVE. The information printed by BDYVEL for each panel are the X, Y, Z of each field point at which the velocities is computed, the inclination angles, DELTA and THETA, and the velocity components, U, V, and W, in the coor ...ate axis directions, and the resultant outward normal velocity to the panel. The inclination angles δ and θ are defined either in the geometry definition. When the field points are read from TAPE 4 the angles are printed out as zero for the lack of better information.

This is the last page for a given case. The program will continue to read additional Mach number and α_c cases or new configurations until the end of data is reached. The output also continues to repeat as specified. The use of TAPE 4, however, is not organized to handle multiple cases at this time.

PROGRAM LISTINGS

The body modeling program is written in FORTRAN IV (029 punch) computer language for the CDC 6600 computer. The program consists of a main program, WDYBDY, and 42 subroutines. A listing of the program subroutine names in alphabetical order follows.

PROGRAM WDYBDY

APPENDIX K

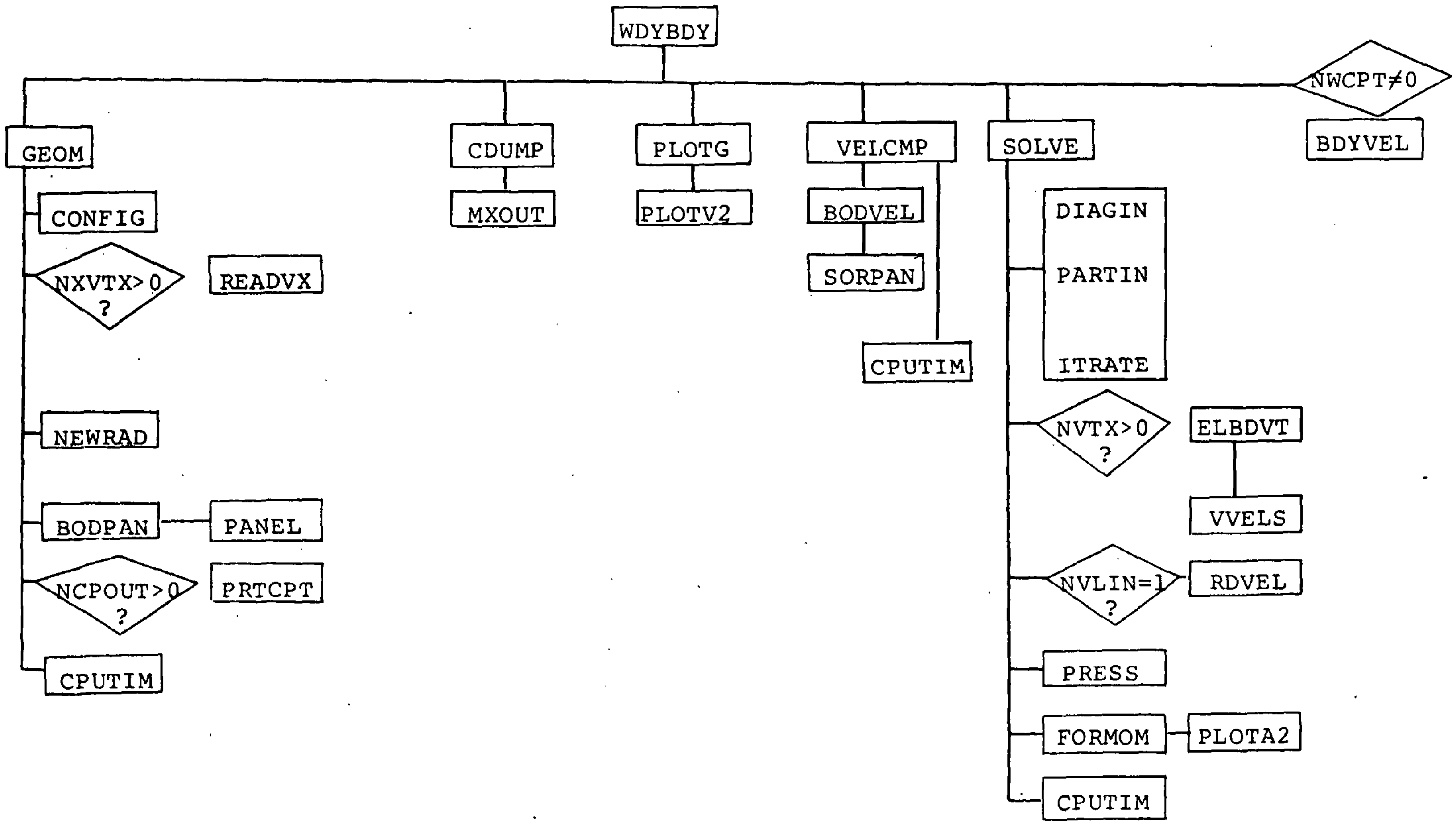


Figure K-1.- Program Subroutine Flow

PROGRAM WDYBDY

```
      PROGRAM WDYBDY(OUTPUT,TAPE6=OUTPUT,TAPE4,TAPE5,TAPE7,
     1 TAPE8,TAPE9,TAPE10)
C     PROGRAM WDYBDY(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7,
CDC   OVERLAY(LWB,0,0)
C
C ----------------------------------------------------------------------
C  BODY ONLY VERSION:                          JOE MULLEN,  JUNE, 1977
C ----------------------------------------------------------------------
C
C     PROGRAM WDYBDY COMPUTES THE SUBSONIC AND SUPERSONIC POTENTIAL
C     FLOW AERODYNAMIC CHARACTERISTICS OF BODY CONFIGURATIONS.
C     THE BODY IS REPRESENTED BY SOURCE PANELS.
C     THE THEORY IS DESCRIBED IN NASA CR-2228 (PART I) AND THE
C     COMPUTER PROGRAM IS DESCRIBED IN NASA CR-2228 (PART II).
C
C     A CONVERGENCE CRITERIA TEST HAS BEEN INCORPORATED INTO SUBROUTINE
C     ITRATE TO CONTROL THE ITERATIVE SOLUTION PROCEDURE. THE MAXIMUM
C     NUMBER OF ITERATIONS AND THE CONVERGENCE CRITERIA TEST PARAMETER
C     HAVE BEEN ADDED TO THE PROGRAM INPUT.
C
C     THE FOLLOWING ARE LIMITATIONS OR KNOWN PROBLEMS
C
C     THE PROGRAM IS INTENDED TO HANDLE 600 BODY PANELS,
C     HOWEVER THE INPUT SPECIFIES CUTTING PLANES RATHER THAN
C     PANELS WHICH MAY LIMIT THE INPUT TO DEFINING LESS THAN 600 PANELS.
C
C     THE PROGRAM WILL NOT HANDLE NACELLES.
C
C     THE TRAILING VORTEX SHEET FROM THE WING LEAVES THE TRAILING EDGE
C     IN A PLANE PARALLEL TO THE X AXIS.
C
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1    ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,IPRINT,NWTHK
     1    ,NWBLOK,NWROW(20),NBBLOK,NBROW(60)
      COMMON /JOPTNS/ IZ1(60)
     *    ,NCPOUT,XSTART,XWLE,NWCPT,IPLOT(4),IPRT(5),IXZSYM
      DIMENSION ICARD(8)
C
      CALL CPUTIM(TIME,DT,0)
      EM=-1.
      XMACH=-1.
      REWIND 5
      WRITE (6,90)
      WRITE (6,100)
C
C   LIST INPUT CARDS
C
10    READ (5,110) ICARD
      IF (EOF(5)) 30,20,30
20    WRITE (6,120) ICARD
      GO TO 10
30    CONTINUE
      REWIND 5
50    WRITE (6,70)
C
C   INPUT CONFIGURATION GEOMETRY AND COMPUTE PANELS
C
      CALL GEOM
CDC   CALL OVERLAY (LWB,1,0)
C
C  GENERATE INTERMEDIATE PRINT AND PLOT GEOMETRY
C
```

```
      CALL CDUMP(IPRT(2),8HEND=GEOM)
      IF (IPLOT(1).GT.0) CALL PLOTG
C
C   INPUT MACH NUMBER AND COMPUTE AERODYNAMIC MATRIX
C   A NEGATIVE MACH NUMBER IS USED TO TERMINATE MACH NUMBER AND ANGLE
C   OF ATTACK CASES FOR A GIVEN GEOMETRY
C
60    CONTINUE
      CALL VELCMP
CDC   CALL OVERLAY (LWB,2,0)
      CALL CDUMP(IPRT(4),8HEND=VELC)
      IF (XMACH.LT.0.) GO TO 50
      WRITE (6,80)
C
C   SOLVE RESULTING MATRIX EQUATIONS AND
C   COMPUTE PRESSURES, FORCES, AND MOMENTS
C
      CALL SOLVE
CDC   CALL OVERLAY (LWB,3,0)
      CALL CDUMP(IPRT(5),8HEND=SOLV)
C
C  COMPUTE ARBITRARY FIELD POINT VELOCITIES
C
      IF (NFCPT.NE.0) CALL BDYVEL
      GO TO 60
   70 FORMAT (1H1,20X,25HBEGIN A NEW CONFIGURATION,64X,12H** WDYBDY **)
   80 FORMAT (1H1,20X,16HBEGIN A NEW CASE,73X,12H** WDYBDY **)
   90 FORMAT (1H1,10X,37HWOODWARD*S SOURCE PANEL BODY MODELING,
     1 8H PROGRAM,10X,16HDATED JUNE, 1977/)
  100 FORMAT (1H0,25X,19HLIST OF INPUT CARDS//)
  110 FORMAT (8A10)
  120 FORMAT (10X,8A10)
      END
```

```
      SUBROUTINE BDYVEL
C
C  COMPUTE THE THREE COMPONENTS OF VELOCITY INDUCED AT SPECIFIED
C  FIELD  POINTS BY THE BODY PANELS.  GIVEN THE STRENGTHS, GB, OF
C  BODY SOURCE PANELS COMPUTE THE FLOW VELOCITY COMPONENTS INDUCED
C  BY BODY SOURCE PANELS AT SPECIFIED POINTS (I.E. WING MONOPLANE
C  CENTROIDS)
C
      COMMON /JOPTNS/ IZ1(62),XWLE,NWCPT,IPLOT(4),IPRT(5),IXZSYM
      COMMON /PARAM / NBODY,NWING,NTAIL,LRC,THK,XMACH,ALPHA,BETA,ALPHAC
     1   ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /VELCOM/ NPOINT,NPART,IZ4(2),NMAX,EM,IPRINT,NWTHK
     1    ,NWBLOK,NWROW(20),NBBLOK,NBROW(60)
      COMMON /NFACOM/K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,K4,K5
     1    ,KF(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT(20),XCPT(20)
      COMMON           U(600),V(600),W(600),VI(600),WI(600),AN(600),
     1    ZB(600),XBT(600),YBT(600),ZBT(600),GW(600),GB(600),Z9(600)
      COMMON /POINT / XPT(600),YPT(600),ZPT(600),THET(600),DELTA(600),
     1    XC(30,20),YC(30,20),ZC(30,20),DELTI(600),XLE(600)
      COMMON /BODCOM/ AMACH,TANO,CX,XCOR(4),YCOR(4),ZCOR(4)
     1    ,XI,YI,ZI,XJ,ZJ
      COMMON /BTHET / THETA(600)
C
      DIMENSION ARRAY(6000)
```

```
      EQUIVALENCE                         (XPT(1),ARRAY(1))
      LOGICAL LBC
      DATA RADDEG/0.0174532926/
      DATA ICASE/0/
      ICASE=ICASE+1
C
      AMACH=XMACH
C
C   READ BODY GEOMETRY COORDINATES
C
      IF (NBODY.LE.0) RETURN
      REWIND 7
      READ (7) ARRAY
      DO 10 I=1,NBODY
      DELTI(I)=DELTA(I)
      THETA(I)=THET(I)
      XBT(I) = XPT(I)
      YBT(I) = YPT(I)
10    ZBT(I) = ZPT(I)
C
C   READ WING CONTROL POINTS
C
      IF (NWCPT.LT.0 .OR. ICASE.GT.1) GO TO 30
C
C   IF NWCPT IS LESS THAN 0 USE BODY POINTS*
C   IF NWCPT IS GREATER THAN 0 READ POINTS FROM INPUT FILE ON TAPE4
C
      REWIND 4
      READ (4,745) NWBP
      READ (4,745) (J,XPT(I),YPT(I),ZPT(I),I=1,NWCPT)
      DO 20 I=1,NWCPT
      THET(I)=0.0
      DELTI(I)=0.0
      XPT(I)=XPT(I)+XWLE
20    CONTINUE
C
C   FIND END OF CONTROL POINT DATA ON TAPE 4.
C
      JP1=NWCPT+1
      IF (NWBP.GT.NWCPT) READ (4,745) (J,XDUM,YDUM,ZDUM,I=JP1,NWBP)
30    IF (NWCPT.LT.0) NWCPT=NBODY
C
C   I IS THE INDEX OF THE FIELD POINT
C   J IS THE INDEX OF THE INFLUENCING PANEL
C
      WRITE(6,170)
C
C     COORDINATES OF I*TH FIELD POINT
C
      DO 110 I=1,NWCPT
      SINTI=SIN(THET(I))
      COSTI=COS(THET(I))
      XPTI=XPT(I)
      YPTI=YPT(I)
      ZPTI=ZPT(I)
C
C              BODY PANEL INCIDENCE ANGLE
C
      SIND=SIN(DELTA(I))
      COSD=COS(DELTA(I))
      SUMU = 0.
      SUMV = 0.
      SUMW = 0.
```

```
      SUMN = 0.
      J=0
      JPN=0
      L=0
      DO 70 KFU=1,KFUS
      NROW=KRADX(KFU)-1
      NCOL=KFCRX(KFU)-1
      DO 60 MC=1,NCOL
      L=L+1
      JP1=1+JPN
      JPN=JP1+NROW-1
      DO 50 N=1,NROW
      J=J+1
      TAND=TAN(DELTA(J))
      COST=COS(THETA(J))
      SINT=SIN(THETA(J))
      XW=SINT*COSTI
      XX=COST*SINTI
      XY=COST*COSTI
      XZ=SINT*SINTI
      SINTR=XW-XX
      COSTR=XY+XZ
      NP1=N+1
      XC1=XC(L,NP1)
      YC1=YC(L,NP1)
      ZC1=ZC(L,NP1)
C
C  CALCULATION OF PANEL CORNER POINTS IN PANEL COORDINATE SYSTEM
C
      XCOR(1)=0.
      YCOR(1)=0.
      ZCOR(1)=0.
      XCOR(2)=XC(L+1,NP1)-XC1
      XCOR(3)=0.
      XCOR(4)=XCOR(2)
      DO 40 K=2,4
      LP1=L+1
      NP1=N+1
      IF (K.GE.3) NP1=N
      IF (K.EQ.3) LP1=L
      DELY=YC(LP1,NP1)-YC1
      DELZ=ZC(LP1,NP1)-ZC1
      YCOR(K)=DELY*COST+DELZ*SINT
      ZCOR(K)=DELZ*COST-DELY*SINT
40    CONTINUE
      CX=XCOR(2)
C
C  CALCULATION OF FIELD   POINT IN PANEL COORDINATE SYSTEM
C
      XI=XPTI-XC1
      DY=YPTI-YC1
      DZ=ZPTI-ZC1
      YI=DY*COST+DZ*SINT
      ZI=DZ*COST-DY*SINT
      XJ=XHT(J)-XC1
      DYJ=YHT(J)-YC1
      DZJ=ZHT(J)-ZC1
      ZJ=DZJ*COST-DYJ*SINT
C
C  CALCULATE VELOCITY COMPONENTS INDUCED BY CONSTANT SOURCE
C  DISTRIBUTION PANELS
C
      CALL SORPAN(UR,VR,WR)
```

```
      UBJ=UR
      VIJ=VR*COSTR-WR*SINTR
      WIJ=VR*SINTR+WR*COSTR
      UL=0.
      VL=0.
      WL=0.
C
C  CALCULATE VELOCITY COMPONENTS FROM LEFT SIDE FOR SYMMETRIC
C  CONFIGURATIONS INDUCED BY CONSTANT SOURCE PANEL
C
      IF (IXZSYM.NE.0) GO TO 45
      SINTL=XW+XX
      COSTL=XY-XZ
      DY=-YPTI-YC1
      YI=DY*COST+DZ*SINT
      ZI=DZ*COST-DY*SINT
      CALL SORPAN(UL,VL,WL)
      UBJ=UBJ+UL
      VIJ=VIJ-VL*COSTL+WL*SINTL
      WIJ=WIJ+VL*SINTL+WL*COSTL
45    CONTINUE
C
C
      VBJ=VIJ*COSTI-WIJ*SINTI
      WBJ=WIJ*COSTI+VIJ*SINTI
      ANJ=WIJ*COSD-UBJ*SIND
      SUMU = SUMU+UBJ*GB(J)
      SUMV = SUMV+VBJ*GB(J)
      SUMW = SUMW+WBJ*GB(J)
      SUMN = SUMN+ANJ*GB(J)
50    CONTINUE
60    CONTINUE
70    CONTINUE
C
C  COMPUTE VELOCITY AT I*TH FIELD POINT
C
      U(I) = SUMU
      V(I) = SUMV
      W(I) = SUMW
      ALP=ALPHA*RADDEG
      PHI=PHIR*RADDEG
      SINAL=SIN(ALP)
      COSAL=COS(ALP)
      SINB=SINAL*SIN(PHI)
      SINA=SINAL*COS(PHI)
      ANI=COSAL*SIN(DELTA(I))+COS(DELTA(I))*(-SINA*COS(THET(I))
     *    +SINB*SIN(THET(I)))
C
C
      WRITE(6,180) I,XPT(I),YPT(I),ZPT(I),THET(I),DELTA(I)
     * ,U(I),V(I),W(I),SUMN
110   CONTINUE
C
C  WRITE VELOCITIES INDUCED AT FIELD POINTS AFTER CONTROL POINT DATA
C     ON TAPE 4.
C
      WRITE(4,745) NWCPT,XMACH,ALPHAC,PHIR
      WRITE(4,745) (I,U(I),V(I),W(I),I=1,NWCPT)
      RETURN
C
170   FORMAT (1H1,10X,44HPERTURBATION VELOCITIES AT SPECIFIED CONTROL
     *   20H POINTS BY SOURCE PANELS ,31X,12H** BDYVEL **
     *   ,///7X,13HCONTROL POINT,20X,12HPANEL ANGLES,10X,10HVELOCITIES,
```

```
     *    //6H  JCPT,5X,1HX,9X,1HY,9X,1HZ,7X,4HTHET,5X,5HDELTA,8X,1HU
     *    ,9X,1HV,9X,1HW,6X,6HNORMAL/)
190   FORMAT(I5,5F10.5,5F10.5)
745   FORMAT(I5,3E12.5)
      END



      SUBROUTINE BODPAN
CDC   OVERLAY (LWB,1,5)
CDC   PROGRAM BODPAN
C
C   REVISE AXIAL SPACING ON BODY (FUSELAGE) AND COMPUTE NEW PANEL
C   GEOMETRY
C
      COMMON /JOPTNS/ IZ1(8)
     1   ,J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,NRADX(4),NFORX(4)
     2   ,NP,NPODOR,NF,NFINOR,NCAN,NCANOR,J2TEST,NW
     3   ,IZ2(34),IPRT(5),IXZSYM
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1   ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON          BLOCK(7500)
      COMMON /POINT / ARRAY(6000)
      COMMON /KEACOM/ K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,K4,K5
     1    ,KF(6),KAN(6),KFINOR(6),KANOR(6),KOL,KCPT,LOCPT(20),XCPT(20)
      COMMON /VELCOM/ NPOINT,NPART,IZ4(2),NMAX,EM,IPRINT,NWTHK
     1    ,NWBLOK,NWROW(20),NBBLOK,NBROW(60)
      COMMON /RTHET / THETA(600)
C
      DIMENSION XB(30),YB(30,30),ZB(30,30),XJ(60),AREA(600),XPT(600),
     1 YPT(600),ZPT(600),THET(600),DELTA(600),XC(30,20),YC(30,20),
     2 ZC(30,20),XFUS(30,4)
C
      EQUIVALENCE (BLOCK(1),XFUS(1,1)), (BLOCK(121),YB(1,1))
     1    ,(BLOCK(3721),XB(1)),          (BLOCK(1921),ZB(1,1))
      EQUIVALENCE (XPT(1),ARRAY(1)),    (YPT(1),ARRAY(601))
     *    ,(ZPT(1),ARRAY(1201)),         (THET(1),ARRAY(1801))
     *    ,(DELTA(1),ARRAY(2401)),       (XC(1,1),ARRAY(3001))
     *    ,(YC(1,1),ARRAY(3601)),        (ZC(1,1),ARRAY(4201))
     *    ,(AREA(1),ARRAY(4801))
C
      XIN(X1,Y1,X2,Y2,Y)=X1+(X2-X1)*(Y-Y1)/(Y2-Y1)
C
      RADEG=180./3.141592654
      REWIND 10
      IF (IPRINT.LT.0) WRITE (6,220)
C
C   CALCULATE COORDINATES OF PANEL CORNERS
C               JP = INDEX OF PANEL NUMBER (TOTAL=NBODY)
C               JM = TOTAL NUMBER OF AXIAL STATIONS (MAX=30)
C
10    J=1
      L=0
      JP=0
      JM=0
      DO 120 NFU=1,NFUS
      KFUSOR=KFORX(NFU)
      NFUSOR=NFORX(NFU)
      KRAD=KRADX(NFU)
      KRAD=IABS(KRAD)
      IF (KRAD.EQ.0) KRAD=NRADX(NFU)
```

```
      READ (10) XB,YB,ZB
      IF (KFUSOR.EQ.0) GO TO 20
C
C   READ IN NEW AXIAL STATIONS (XJ) FOR BODY (FUSELAGE)
C
      READ (5,210) (XJ(K),K=1,KFUSOR)
      GO TO 50
20    KFUSOR=NFORX(NFU)
      IF (KFUSOR.LE.30) GO TO 30
      WRITE (6,190) NFU
      STOP 20
C
C  USE ORIGINAL AXIAL STATIONS XJ=XFUS
30    KFORX(NFU)=KFUSOR
      DO 40 K=1,KFUSOR
      XJ(K)=XFUS(K,NFU)
40    CONTINUE
50    JM=JM+KFUSOR
      IF (JM.LE.30) GO TO 60
      WRITE (6,200)
      STOP 50
C
C  INITIALIZE COORDINATES EQUAL TO SEGMENT LEADING EDGE
60    DO 70 K=1,KRAD
      XC(J,K)=XB(1)
      YC(J,K)=YB(1,K)
      ZC(J,K)=ZB(1,K)
70    CONTINUE
C
C  INTERPOLATE FOR REMAINING PANEL COORDINATES -------------------------
      DO 110 JJ=2,KFUSOR
      JM1=J
      J=J+1
C
C  FIND X-STATION
C
      DO 100 M=2,NFUSOR
      MM1=M-1
      IF (XB(M).LT.XJ(JJ)) GO TO 100
      DO 90 K=1,KRAD
      XC(J,K)=XJ(JJ)
      YC(J,K)=XIN(YB(MM1,K),XB(MM1),YB(M,K),XB(M),XJ(JJ))
      ZC(J,K)=XIN(ZB(MM1,K),XB(MM1),ZB(M,K),XB(M),XJ(JJ))
      IF (K.EQ.1) GO TO 90
      KM1=K-1
      JP=JP+1
C
C   CALCULATE PANEL INCLINATION AND CENTROID
C
      CALL PANEL(0,0,J,K,L,JP,AP)
C
C  PRINT BODY PANEL COORDINATES
      IF (IPRINT.GE.0) GO TO 80
      WRITE (6,240) JP,XC(JM1,KM1),YC(JM1,KM1),ZC(JM1,KM1),XC(J,KM1),
     1   YC(J,KM1),ZC(J,KM1),XC(JM1,K),YC(JM1,K),ZC(JM1,K),
     2   XC(J,K),YC(J,K),ZC(J,K)
80    AREA(JP)=AP
90    CONTINUE
      GO TO 110
100   CONTINUE
110   CONTINUE
120   CONTINUE
C
```

```
      NBODY=JP
      IF (NBODY.GT.600) GO TO 170
      IF (IPRINT.GE.0) GO TO 150
      WRITE (6,250)
      DO 130 JP=1,NBODY
      WRITE (6,270) JP,XPT(JP),YPT(JP),ZPT(JP)
130   CONTINUE
      WRITE (6,280)
      DO 140 JP=1,NBODY
      DDEG=DELTA(JP)*RADEG
      TDEG=THET(JP)*RADEG
      WRITE (6,270) JP,AREA(JP),DELTA(JP),THET(JP),DDEG,TDEG
140   CONTINUE
150   DO 160 JP=1,NBODY
      THETA(JP)=THET(JP)
160   CONTINUE
C
C     STORE BODY GEOMETRY ON TAPE 7
C
      WRITE (7) ARRAY
      REWIND 10
      RETURN
170   WRITE (6,300)
      STOP
190   FORMAT (50H  ERROR - NUMBER OF ROWS OF PANELS IN BODY SECTION
     1 ,I5,2X,10HEXCEEDS 30)
200   FORMAT (49H  ERROR - NUMBER OF ROWS OF SINGULARITY PANELS ON
     1 16H BODY EXCEEDS 30)
210   FORMAT (10F7.0)
220   FORMAT (1H1,9X,35HBODY PANEL CORNER POINT COORDINATES
     * 65X,12H** BODPAN **,///10X,5H1 AND
     1 60H 3 INDICATE BODY PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE
     2 21H TRAILING-EDGE POINTS/5X,5HPANEL,4(8X,1HX,8X,1HY,8X,1HZ)/
     3 19X,3(1H1,8X),3(1H2,8X),3(1H3,8X),3(1H4,8X)/)
240   FORMAT (I8,4X,12F9.5)
250   FORMAT (1H1,38H BODY PANEL CENTROID POINT COORDINATES
     1 //4X,5HPOINT,4X,1HX,10X,1HY,10X,1HZ/15X,3(2HCP,9X)/)
270   FORMAT (I8,1X,4F11.5,F11.3)
280   FORMAT (1H1,4X,39HBODY PANEL AREAS AND INCLINATION ANGLES/
     1 1H0,3X,5HPANEL,2X,4HAREA,7X,5HDELTA,6X,5HTHETA,6X,5HDELTA,6X,
     2 5HTHETA/24X,3HRAD,8X,3HRAD,8X,3HDEG,8X,3HDEG/)
300   FORMAT (43H  ERROR - NUMBER OF BODY PANELS EXCEEDS 600)
      END
```

```
      SUBROUTINE BODVEL
C
C     COMPUTE THE THREE COMPONENTS OF VELOCITY INDUCED AT SPECIFIED
C     CONTROL POINTS BY THE BODY PANELS
C
      COMMON /JOPTNS/ IZ1(73),IXZSYM
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1    ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,IPRINT,NWTHK
     1    ,NWBLOK,NWROW(20),NBBLOK,NBROW(30)
      COMMON /NEWCOM/K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,K4,K5
     1    ,KF(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT(20),XCPT(20)
      COMMON             UB(600),VB(600),WB(600),VI(600),WI(600),AN(600),
     1    DN(60),ZB(240),XBT(600),YBT(600),ZBT(600),IT(600),Z9(1200)
```

```
      COMMON /POINT / XPT(600),YPT(600),ZPT(600),THET(600),DELTA(600),
     1   XC(30,20),YC(30,20),ZC(30,20),DELTI(600),XLE(600)
      COMMON /BODCOM/ AMACH,TAND,CX,XCOR(4),YCOR(4),ZCOR(4)
     1   ,XI,YI,ZI,XJ,ZJ
      COMMON /BTHET / THETA(600)
      LOGICAL LBC
      AMACH=XMACH
      JMAX=MAX
      II=0
C
C  I IS THE INDEX OF THE CONTROL POINT
C  J IS THE INDEX OF THE INFLUENCING PANEL
C
      DO 110 I=1,NPOINT
      IF (LBC .AND. I.EQ.IT(I) .AND. NPART.EQ.3) GO TO 110
      II=II+1
      SINTI=SIN(THET(I))
      COSTI=COS(THET(I))
      XPTI=XPT(I)
      YPTI=YPT(I)
      ZPTI=ZPT(I)
      IF (NPART.EQ.3) GO TO 10
C              BODY PANEL INCIDENCE ANGLE
      SIND=SIN(DELTA(I))
      COSD=COS(DELTA(I))
      GO TO 20
C              WING PANEL INCIDENCE ANGLE
10    DELT=0.
CNP   IF (.NOT.LBC) DELT=DELTI(I)
      SIND=SIN(DELT)
      COSD=COS(DELT)
20    DO 30 J=1,NBODY
      UB(J)=0.
      VI(J)=0.
      WI(J)=0.
30    CONTINUE
      J=0
      JPN=0
      L=0
      DO 70 KFU=1,KFUS
      NROW=KRADX(KFU)-1
      NCOL=KFORX(KFU)-1
      DO 60 NC=1,NCOL
      L=L+1
      JP1=1+JPN
      JPN=JP1+NROW-1
      DO 50 N=1,NROW
      J=J+1
      TAND=TAN(DELTA(J))
      COST=COS(THETA(J))
      SINT=SIN(THETA(J))
      XW=SINT*COSTI
      XX=COST*SINTI
      XY=COST*COSTI
      XZ=SINT*SINTI
      SINTR=XW-XX
      SINTL=XW+XX
      COSTR=XY+XZ
      COSTL=XY-XZ
      NP1=N+1
      XC1=XC(L,NP1)
      YC1=YC(L,NP1)
      ZC1=ZC(L,NP1)
```

```
C
C   CALCULATION OF PANEL CORNER POINTS IN PANEL COORDINATE SYSTEM
C
      XCOR(1)=0.
      YCOR(1)=0.
      ZCOR(1)=0.
      XCOR(2)=XC(L+1,NP1)-XC1
      XCOR(3)=0.
      XCOR(4)=XCOR(2)
      DO 40 K=2,4
      LP1=L+1
      NP1=N+1
      IF (K.GE.3) NP1=N
      IF (K.EQ.3) LP1=L
      DELY=YC(LP1,NP1)-YC1
      DELZ=ZC(LP1,NP1)-ZC1
      YCOR(K)=DELY*COST+DELZ*SINT
      ZCOR(K)=DELZ*COST-DELY*SINT
40    CONTINUE
      CX=XCOR(2)
C
C   CALCULATION OF CONTROL POINT IN PANEL COORDINATE SYSTEM
C
      XI=XPTI-XC1
      DY=YPTI-YC1
      DZ=ZPTI-ZC1
      YI=DY*COST+DZ*SINT
      ZI=DZ*COST-DY*SINT
      XJ=XBT(J)-XC1
      DYJ=YBT(J)-YC1
      DZJ=ZBT(J)-ZC1
      ZJ=DZJ*COST-DYJ*SINT
C
C   CALCULATE VELOCITY COMPONENTS INDUCED BY CONSTANT SOURCE
C   DISTRIBUTION PANELS
C
      CALL SORPAN(UR,VR,WR)
      UB(J)=UR
      VI(J)=VR*COSTR-WR*SINTR
      WI(J)=VR*SINTR+WR*COSTR
      UL=0.
      VL=0.
      WL=0.
C
C   CALCULATE VELOCITY COMPONENTS FROM LEFT SIDE FOR SYMMETRIC
C   CONFIGURATIONS INDUCED BY CONTANT SOURCE PANEL
C
      IF (IXZSYM.NE.0) GO TO 45
      DY=-YPTI-YC1
      YI=DY*COST+DZ*SINT
      ZI=DZ*COST-DY*SINT
      CALL SORPAN(UL,VL,WL)
      UB(J)=UB(J)+UL
      VI(J)=VI(J)-VL*COSTL+WL*SINTL
      WI(J)=WI(J)+VL*SINTL+WL*COSTL
45    CONTINUE
C
C   CALCULATE VELOCITY COMPONENTS IN ORIGINAL COORDINATE SYSTEM
C
      VB(J)=VI(J)*COSTI-WI(J)*SINTI
      WB(J)=WI(J)*COSTI+VI(J)*SINTI
      AN(J)=WI(J)*COSD-UB(J)*SIND
      IF (NPART.GT.1.OR.NBODY.LE.NMAX) GO TO 50
```

```
      IF (II.LT.JP1.OR.II.GT.JPN) GO TO 50
      JS1=JP1
      JS2=JPN
      NS=NROW
50    CONTINUE
60    CONTINUE
70    CONTINUE
      JMAX=L
      IF (NBODY.LE.NMAX.OR.NPART.GT.1) GO TO 90
C
C  STORE DIAGONAL BLOCKS OF AERODYNAMIC MATRIX IN DN ARRAY
C
      DO 80 J=1,NBODY
      IF (J.LT.JS1.OR.J.GT.JS2) GO TO 80
      K=J-JS1+1
      DN(K)=AN(J)
      AN(J)=0.
80    CONTINUE
      WRITE (10) (DN(J),J=1,NS)
90    IF (IABS(IPRINT).LT.4) GO TO 100
      WRITE (6,160) II
      WRITE (6,120) NBODY
      WRITE (6,150) (UB(J),J=1,NBODY)
      WRITE (6,130) NBODY
      WRITE (6,150) (AN(J),J=1,NBODY)
      IF (NBODY.LE.NMAX.OR.NPART.NE.1) GO TO 100
      WRITE (6,140) NS
      WRITE (6,150) (DN(J),J=1,NS)
100   WRITE (8) (UB(J),VB(J),WB(J),J=1,NBODY)
      WRITE (9) (AN(J),J=1,NBODY)
110   CONTINUE
      RETURN
120   FORMAT (2X,10HUB(J),J=1,,I3)
130   FORMAT (2X,10HAN(J),J=1,,I3)
140   FORMAT (2X,10HDN(J),J=1,,I3)
150   FORMAT (1X,10F10.5)
160   FORMAT (1H0,22HAERODYNAMIC MATRIX, I=,I3)
      END
```

```
      SUBROUTINE CDUMP(IPRNT,ROUTIN)
C
C  ROUTINE TO PRINT LABELED COMMON BLOCK DATA BY REQUEST.
C  INFORMATION TO BE PRINTED IS DETERMINED BY PRINT OPTION IPRNT.
C
C  PRINT CONTROL
C    IPRNT = 0 - PRINT ROUTINE NAME ONLY
C          = 1, PRINTS VARIABLES AND ARRAYS LESS THAN 11 IN LENGTH
C               FOR COMMON BLOCKS: JOPTNS, PARAM, NEWCOM, VELCOM, + SEG
C          = 2, PRINTS ALL OF ABOVE COMMON BLOCKS
C          = 3, PRINT ARRAY BLOCK
C          = 4, PRINT VARIABLE - ARRAY
C          = 5, PRINTS COMMON: COMPS
C          = 6, PRINTS COMMON: TRAN
C          = 7, PRINTS COMMON: BTHET
C          = 8, PRINTS COMMON: COEF, MATCOM, + ITERAT
C    ROUTIN = HOLLERITH VARIABLE WITH NAME OF CALLING PROGRAM
C             SPECIFIED AS 8H--------.
C
```

```
C?C   DIMENSION ROUTIN(2)
C
      COMMON /JOPTNS/ IZ1(8)
     1    ,J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,NRADX(4),NFORX(4)
     2    ,NP,NPODOR,NF,NFINOR,NCAN,NCANOR,J2TEST,NW,IZ2(25)
     3    ,NVLIN,NCPOUT,XSTART,XWLE,NWCPT,IPLOT(4),IPRT(5),IXZSYM
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1    ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /HEAD  / TITLE1(8),TITLE2(8)
      COMMON /SEG   / NSEG,NROW(20),NCOL(20),COSS(20),SINS(20)
     1    ,BTE(20),NWT(20),SPN(20),XLEW(20),BLE(20),ZLEW(20),ZB(60)
      COMMON               BLOCK(7500)
      COMMON /POINT / ARRAY(6000)
      COMMON /NEWCOM/ K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,K4,K5
     1    ,KF(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT(20),XCPT(20)
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,IPRINT,NWTHK
     1    ,NWBLOK,NWROW(20),NBBLOK,NBROW(60)
      COMMON /COMPS / TCOMPS(11)
      COMMON /TRAN  / TTRAN(12)
      COMMON /HTHET / THETI(606)
      COMMON /MATCOM/ MATIN
      COMMON /COEF  / TCOEF(400)
      COMMON /ITERAT/ ITMAX,CCTEST
C
      IF (IPRINT.LE.0) RETURN
      IF (IPRNT.GE.0) WRITE(6,10) ROUTIN
10    FORMAT(1H1,10X,31HCOMMON BLOCK PRINT CALLED FROM ,A8)
C
      IF (IPRNT.EQ.1 .OR. IPRNT.EQ.2)
     *    WRITE(6,15) J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR
     *    ,NFUS,NRADX,NFORX,NP,NPODOR,NF,NFINOR,NCAN,NCANOR
     *    ,J2TEST,NW,NVLIN,NCPOUT,NWCPT,IPLOT,IPRT,IXZSYM
     *    ,NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC,PHIR
     *    ,REFA,REFB,REFC,REFD,REFL,REFX,REFZ,XSTART,XWLE
      IF (IPRNT.EQ.1 .OR. IPRNT.EQ.2)
     *    WRITE(6,16) K1,KWAF,KWAFOR,KRADX,KFORX,KFUS,MAX,K4
     *    ,KF,K5,KAN,KFINOR,KANOR,KOL,NCPT
     *    ,NPOINT,NPART,IMAX,JMAX,NMAX,IPRINT,NWTHK,NWBLOK,NBBLOK
     *    ,EM,NSEG
15    FORMAT(/5X,15HCOMMON /JOPTNS/
     *  ,/49H       J0       J1       J2       J3       J4       J5       J6,/7I7
     *  ,/49H    NWAF NWAFOR    NFUS   NRADX      (2)      (3)      (4),/7I7
     *  ,/49H   NFORX      (2)      (3)      (4)       NP NPODOR       NF,/7I7
     *  ,/49H NFINOR     NCAN NCANOR J2TEST        NW   NVLIN NCPOUT,/7I7
     *  ,/49H   NWCPT   IPLOT      (2)      (3)      (4)     IPRT      (2),/7I7
     *  ,/28H      (3)      (4)      (5) IXZSYM,/4I7,
     *  ,//5X,15HCOMMON /PARAM /
     *  ,/35H   NBODY   NWING   NTAIL     LBC      THK,/3I7,2L7
     *  ,/4X,5HXMACH,7X,5HALPHA,8X,4HBETA,6X,6HALPHAC,8X,4HPHIR,/5G12.5
     *  ,/5X,4HREFA,8X,4HREFB,8X,4HREFC,8X,4HREFD,8X,4HREFL,/5G12.5
     *   ,/5X,4HREFX,8X,4HREFZ,6X,6HXSTART,8X,4HXWLE,/4G12.5)
16    FORMAT(/5X,15HCOMMON /NEWCOM/
     *    ,/49H       K1     KWAF KWAFOR    KRADX      (2)      (3)      (4),/7I7
     *    ,/49H   KFORX      (2)      (3)      (4)     KFUS      MAX       K4,/7I7
     *    ,/49H       KF      (2)      (3)      (4)      (5)      (6)       K5,/7I7
     *    ,/7H      KAN,/6I7
     *    ,/7H KFINOR,6I7
     *    ,/7H   KANOR,6I7
     *    ,/14H      KOL    NCPT,/2I7
     *    ,//5X,15HCOMMON /VELCOM/
     *    ,/49H NPOINT   NPART     IMAX     JMAX     NMAX IPRINT    NWTHK,/7I7
     *    ,/21H NWBLOK NBBLOK          EM,/2I7,G12.5
     *    ,//5X,15HCOMMON /SEG   /
```

```
     *    ,/7H    NSEG,/I7)
C
      IF (IPRNT.EQ.2) WRITE(6,20) I22
      IF (IPRNT.EQ.2) WRITE(6,21) NROW,NCOL,COSS,SINS,BTE,NAT,SPNW,XLEW
     *                            ,RLE,ZLEW
      IF (IPRNT.EQ.2) WRITE(6,22) LOCPT,XCPT
      IF (IPRNT.EQ.2) WRITE(6,23) NWROW,NBROW
20    FORMAT(/5X,6HARRAYS,/7H     I22,2(/10I5))
21    FORMAT(7H    NROW,2(/10I5)
     *    ,/7H    NCOL,2(/10I5)
     *    ,/7H    COSS,2(/10G12.5)
     *    ,/7H    SINS,2(/10G12.5)
     *    ,/7H     BTE,2(/10G12.5)
     *    ,/7H     NAT,2(/10I5)
     *    ,/7H    SPNW,2(/10G12.5)
     *    ,/7H    XLEW,2(/10G12.5)
     *    ,/7H     RLE,2(/10G12.5)
     *    ,/7H    ZLEW,2(/10G12.5))
22    FORMAT(7H   LOCPT,2(/10I5)
     *    ,/7H    XCPT,2(/10G12.5))
23    FORMAT(7H   NWROW,2(/10I5)
     *    ,/7H   NBROW,6(/10I5))
C
C  IPRNT=3 - ARRAY BLOCK
C
      IF (IPRNT.EQ.3)
     *   CALL MXOUT(8H COMP   ,1,,BLOCK,10,750,60,132,3,10,750)
C
C  IPRNT=4, VARIABLE ARRAY
C
      IF (IPRNT.EQ.4)
     *   CALL MXOUT(8H COMP   ,1,ARRAY,10,600,60,132,3,10,600)
C
C  IPRNT=5, COMMON /COMPS/
      IF (IPRNT.EQ.5) WRITE(6,30) TCOMPS
30    FORMAT(/5X,15HCOMMON /COMPS /,2(/10G12.5))
C
C  IPRNT=6,  COMMON /TRAN  /
      IF (IPRNT.EQ.6) WRITE(6,35) TTRAN
35    FORMAT(/5X,15HCOMMON /TRAN  /,2(/10G12.5))
C
C  IPRNT=7, COMMON /BTHET /
      IF (IPRNT.EQ.7) WRITE(6,40) THETI
40    FORMAT(/5X,15HCOMMON /BTHET /,60(/10G12.5))
C
C  IPRNT=8, COMMON COEF,MATCOM,ITERAT
      IF (IPRNT.EQ.8) WRITE(6,45) TCOEF,MATIN,ITMAX,CCTEST
45    FORMAT(/5X,15HCOMMON /COEF  /,40(/10G12.5)
     *    ,//5X,15HCOMMON /MATCOM/,10X,7H  MATIN, I5
     *    ,//5X,15HCOMMON /ITERAT/
     *    ,10X,7H  ITMAX,I5,7H CCTEST,G12.5)
      RETURN
      END
```

```
      SUBROUTINE CPUTIM(T,DT,IT)
C
C  ROUTINE TO COMPUTE ABSOLUTE AND RELATIVE CPUTIME DURING EXECUTION
C        * * * *  UNITS - SECONDS  * * * *
C
```

```
C   USAGE:
C   (IT=0) TIME IS INITIALIZED BY FIRST CALL AS T=0, DT=0
C             CALL CPUTIM(T,DT,0)
C
C   (IT=1) COMPUTE ABSOLUTE AND INCREMENT IN CPU TIME FROM INITIAL
C            AND LAST CALL TO *CPUTIM*.
C              T = TOTAL SECONDS FROM INITAL CALL TO *CPUTIM*
C                  AS OUTPUT, T = TIME AT CURRENT CALL
C             DT = INCREMENT IN TIME (SECONDS)
C                  DT = T(CUR)-T(PREV)
C
C   BY JOSEPH PULLEN, JR                          OCTOBER, 1973
C
C        * * * * *    CDC - VERSION    * * * * *
      IF (IT.LE.0) GO TO 100
C
C  COMPUTE NEW TIME AND INCREMENT
      CALL SECOND(TIME)
      TIME = TIME-T0
      DT   = TIME-TSAV
      T    = TIME
      TSAV = TIME
      RETURN
C
C  INITIALIZE CPU TIME
100   T    = 0.0
      DT   = 0.0
      TIME = 0.0
      TSAV = 0.0
      CALL SECOND(T0)
      RETURN
      END
```

```
      SUBROUTINE COMCU(DA,DB,S,X,Y,M,N,NDA,NDB)
C
C   FIT A COMPOSITE CUBIC THROUGH N POINTS, I. E., A SEPARATE CUBIC
C   BETWEEN EACH PAIR OF ADJACENT POINTS, SUCH THAT N-1 CUBICS ARE SO
C   DETERMINED THAT EACH MATCHES ITS NEIGHBORS IN FUNCTION VALUE AND
C   IN THE FIRST AND SECOND DERIVATIVES.
C
      COMMON/COEF/C(50),D(50),E(50),Z1(250)
      DIMENSION S(N),X(N),Y(N)
      K=N-1
      KUF=0
C              TEST FOR N LESS THAN 2
      IF (N-2) 10,20,60
10    M=-1
      RETURN
C              TEST FOR N EQUAL TO 2
20    IF (NDA.NE.1.OR.NDB.NE.1) GO TO 50
      S(1)=DA
      S(2)=DB
      M=0
      RETURN
50    KUF=1
60    M=0
      E(1)=0.
      C(N)=0.
      IF (NDA.GT.1) GO TO 80
```

```
      D(1)=1.
      C(1)=0.
      S(1)=DA
      GO TO 90
80    D(1)=4.
      C(1)=2.
      S(1)=6.*(Y(2)-Y(1))/(X(2)-X(1))-DA*(X(2)-X(1))
90    IF (KUE.NE.0) GO TO 120
      DO 110 I=2,K
      U=X(I)-X(I-1)
      V=X(I+1)-X(I)
      C(I)=U
      D(I)=2.*(U+V)
      E(I)=V
      S(I)=6./(U*V)*(U*U*(Y(I+1)-Y(I))+V*V*(Y(I)-Y(I-1)))
110   CONTINUE
120   IF (NDB.GT.1) GO TO 140
      E(N)=0.
      D(N)=1.
      S(N)=DB
      GO TO 150
140   E(N)=2.
      D(N)=4.
      S(N)=6.*(Y(N)-Y(N-1))/(X(N)-X(N-1))+DB*(X(N)-X(N-1))
150   C(1)=C(1)/D(1)
      S(1)=S(1)/D(1)
      DO 160 I=2,N
      F=D(I)-C(I-1)*E(I)
      C(I)=C(I)/F
      S(I)=(S(I)-S(I-1)*E(I))/F
160   CONTINUE
      DO 170 J=1,K
      I=N-J
      S(I)=S(I)-S(I+1)*C(I)
170   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE CONFIG
C
C     INPUT AND INITIALIZE CONFIGURATION DESCRIPTION
C
      COMMON /JOPTNS/ IZ1(8)
     1   ,J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,NRADX(4),NFORX(4)
     2   ,NP,NPODOR,NF,NFINOR,NCAN,NCANOR,J2TEST,NW
     3   ,IZ2(34),IPRT(5),IXZSYM
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1   ,PHIP,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON          BLOCK(7500)
C
C  GEOMETRY ARRAYS
C         WING               BODY              V.FIN             H.TAIL
      DIMENSION ABCD(8)
     1 ,     XAF(30)      ,    XFUS(30,4)    , FINORG(6,2,4) , CANORG(6,2,4)
     2 ,WAFORG(20,4)      ,    ZFUS(30,4)    ,   XFIN(6,10)  ,   XCAN(6,10)
     3 ,WAFORD(20,3,40), FUSARD(30,4)        , FINORD(6,2,10), CANORD(6,2,10)
     4 , TZORD(20,30)     , FUSRAD(30,4)     ,  FINX2(6,2,10), CANOR1(6,2,10)
     5 , WAFOR(20,30)     ,    SFUS(30,30,8),  FINX3(6,2,10), CANORX(6,2,10)
     6 ,                     FUSBY(30,4)     ,  FINOR(6,10)  ,  CANOR(6,10)
```

```
     7 ,                   FUSAZ(30,4)    , FINCR(6,10)   , CANCR(6,10)
C
C               WING                                 BODY
      EQUIVALENCE
     1  (   XAF(1)     ,BLOCK(1))     ,    (  XFUS(1,1)   ,BLOCK(1))
     2  ,(WAFORG(1,1)  ,BLOCK(31))    ,    (  ZFUS(1,1)   ,BLOCK(121))
     3  ,(WAFORD(1,1,1),BLOCK(111))   ,    (FUSARD(1,1)   ,BLOCK(241))
     4  ,( TZORD(1,1)  ,BLOCK(1911)),      (FUSRAD(1,1)   ,BLOCK(361))
     5  ,( WAFOR(1,1)  ,BLOCK(2511)),      (  SFUS(1,1,1),BLOCK(241))
     6  ,                                  ( FUSRY(1,1)   ,BLOCK(361))
     7  ,                                  ( FUSAZ(1,1)   ,BLOCK(481))
C               V.FIN                                H.TAIL
      EQUIVALENCE
     6    (FINORG(1,1,1),BLOCK(1))    ,    (CANORG(1,1,1),BLOCK(1))
     7  ,(  XFIN(1,1)  ,BLOCK(49))    ,    (  XCAN(1,1)   ,BLOCK(49))
     8  ,(FINORD(1,1,1),BLOCK(109))   ,    (CANORD(1,1,1),BLOCK(109))
     9  ,( FINX2(1,1,1),BLOCK(229))   ,    (CANOR1(1,1,1),BLOCK(229))
     0  ,( FINX3(1,1,1),BLOCK(349))   ,    (CANORX(1,1,1),BLOCK(349))
     1  ,( FINOR(1,1)  ,BLOCK(469))   ,    ( CANOR(1,1)   ,BLOCK(469))
     2  ,( FINCR(1,1)  ,BLOCK(529))   ,    ( CANCR(1,1)   ,BLOCK(529))
C
      LOGICAL LPRT,READA,READR,READF
      DATA PI/3.14159265/
      REWIND 9
      LPRT=IPRT(1).GT.0
C
C     REFERENCE AREA
C
      REFA=1.
      IF (J0.NE.0) READ (5,480) REFA
CB    WRITE (9) REFA
      IF (LPRT) WRITE(6,490) REFA
C
C     WING  ------------------------------------------------------------
C
      IF (J1.EQ.0) GO TO 160
      IF (LPRT) WRITE(6,500)
      N=IABS(NWAFOR)
      NREC=(N+9)/10
      I1=-9
      I2=0
      DO 20 NN=1,NREC
      I1=I1+10
      I2=I2+10
      READ (5,480) (XAF(I),I=I1,I2)
      IF (LPRT) WRITE(6,510) NN,(XAF(I),I=I1,I2)
   20 CONTINUE
C
      IF (LPRT) WRITE(6,520)
      DO 30 I=1,NWAF
      READ (5,480) (WAFORG(I,J),J=1,4)
      IF (LPRT) WRITE(6,510) I,(WAFORG(I,J),J=1,4)
   30 CONTINUE
C
C     J1 = -1 INDICATES UNCAMBERED WING DATA
C
      IF (J1.LT.0) GO TO 60
      IF (LPRT) WRITE(6,540)
      DO 50 NN=1,NWAF
      I1=-9
      I2=0
      DO 40 NI=1,NREC
```

```
      I1=I1+10
      I2=I2+10
      READ (5,480) (TZORD(NN,I),I=I1,I2)
      DO 40 I=I1,I2
      IF (WAFORG(NN,4).EQ.0.) GO TO 40
      TZORD(NN,I)=TZORD(NN,I)*100./WAFORG(NN,4)
   40 CONTINUE
      IF (LPRT) WRITE(6,510) NN,(TZORD(NN,I),I=I1,I2)
   50 CONTINUE
      GO TO 80
   60 DO 70 I=1,NWAF
      DO 70 K=1,N
      TZORD(I,K)=0.
   70 CONTINUE
   80 L=1
C
C     NWAFOR POSITIVE INDICATES SYMMETRICAL ORDINATES
C            NEGATIVE INDICATES UPPER AND LOWER ORDINATES GIVEN
C
      IF (NWAFOR.LT.0) L=2
      IF (LPRT) WRITE(6,550)
      DO 100 NN=1,NWAF
      DO 100 K=1,L
      I1=-9
      I2=0
      DO 90 N1=1,NREC
      I1=I1+10
      I2=I2+10
      READ (5,480) (WAFORD(NN,K,I),I=I1,I2)
      IF (LPRT) WRITE(6,510) NN,(WAFORD(NN,K,I),I=I1,I2)
   90 CONTINUE
  100 CONTINUE
      DO 110 NN=1,NWAF
      DO 110 K=1,N
      WAFOR(NN,K)=WAFORD(NN,1,K)
      IF (L.EQ.1) GO TO 110
      WAFOR(NN,K)=(WAFORD(NN,1,K)+WAFORD(NN,2,K))/2.
      TZORD(NN,K)=(WAFORD(NN,1,K)-WAFORD(NN,2,K))/2.+TZORD(NN,K)
  110 CONTINUE
      IF (NWAFOR.LT.0) GO TO 130
      DO 120 NN=1,NWAF
      DO 120 K=1,N
      WAFORD(NN,2,K)=WAFORD(NN,1,K)
  120 CONTINUE
  130 NWAFOR=IABS(NWAFOR)
      NW=NWAFOR
      J1=IABS(J1)
C
C     CHANGE WING TO ACTUAL UNITS
C
      DO 150 I=1,NWAF
      E=.01*WAFORG(I,4)
      E3=WAFORG(I,3)
      DO 140 J=1,NWAFOR
      WAFORD(I,1,J)=E*WAFORD(I,1,J)+E3+TZORD(I,J)*E
      WAFORD(I,2,J)=-E*WAFORD(I,2,J)+E3+TZORD(I,J)*E
      WAFORD(I,3,J)=WAFORG(I,1)+E*XAF(J)
  140 CONTINUE
  150 CONTINUE
C*    WRITE (9) BLOCK
  160 CONTINUE
      N=IABS(NWAFOR)
C
C     FUSELAGE (BODY) ----------------------------------------
```

```
C
      IF (J2.EQ.0) GO TO 290
      J2TEST=3
C
C     J2 < 0 AND J6 = -1 INDICATE CIRCULAR/ELLIPTIC FUSELAGE SYMMETRICAL
C                       WITH THE XY-PLANE
C     J2 < 0 AND J6 = 0 INDICATE CIRCULAR/ELLIPTIC CAMBERED FUSELAGE
C     J6 = 1 INDICATES COMPLETE CONFIGURATION SYMMETRICAL WITH THE
C            XY-PLANE
C     J2 = -1, READ FUSELAGE CROSS SECTIONAL AREAS VS XFUS ON INPUT
C     J2 = -2, READ FUSELAGE RADII VS XFUS ON INPUT
C     J2 = -3, READ ELLIPTIC FUSELAGE SEMI-MAJOR AXES VS XFUS
C
      IF (J2.LE.-1.AND.J6.EQ.-1) J2TEST=1
      IF (J2.LE.-1.AND.J6.EQ.0) J2TEST=2
      IF (J6.EQ.1) J2TEST=1
      READA=J2.EQ.-1
      READR=J2.EQ.-2
      READE=J2.EQ.-3
      J2=1
C
C     READ XFUS
      IF (LPRT) WRITE(6,570)
      DO 290 NFU=1,NFUS
      NRAD=NRADX(NFU)
      NFUSOR=NFORX(NFU)
      N=NFUSOR
      NREC=(N+9)/10
      I1=-9
      I2=0
      DO 170 NI=1,NREC
      I1=I1+10
      I2=I2+10
      READ (5,480) (XFUS(I,NFU),I=I1,I2)
      IF (LPRT) WRITE(6,510) NFU,(XFUS(I,NFU),I=I1,I2)
170   CONTINUE
C
C     J2TEST = 2 INDICATES CIRCULAR/ELLIPTIC CAMBERED FUSELAGE
C
      IF (J2TEST.NE.2) GO TO 190
      I1=-9
      I2=0
      IF (LPRT) WRITE(6,580)
      DO 180 NI=1,NREC
      I1=I1+10
      I2=I2+10
      READ (5,480) (ZFUS(I,NFU),I=I1,I2)
      IF (LPRT) WRITE(6,510) NFU,(ZFUS(I,NFU),I=I1,I2)
180   CONTINUE
      GO TO 210
190   DO 200 I=1,NFUSOR
      ZFUS(I,NFU)=0.
200   CONTINUE
C
C     J2TEST = 3 INDICATES ARBITRARY FUSELAGE - READ YJ + ZJ OF SECTION
C
210   IF (J2TEST.NE.3) GO TO 250
      NCARD=(NRAD+9)/10
      DO 240 JX=1,NFUSOR
      DO 230 K=1,2
      IF (LPRT.AND.K.EQ.1) WRITE(6,590)
      IF (LPRT.AND.K.EQ.2) WRITE(6,600)
      KK=K+(NFU-1)*2
```

```
      II=10
      I1=-9
      I2=0
      DO 220 NN=1,NCARD
      IF (NN.EQ.NCARD) II=MOD(NRAD,10)
      IF (II.EQ.0) II=10
      I1=I1+10
      I2=I2+II
      READ (5,480) (SFUS(I,JX,KK),I=I1,I2)
      IF (LPRT) WRITE(6,510) JX,(SFUS(I,JX,KK),I=I1,I2)
220   CONTINUE
230   CONTINUE
240   CONTINUE
      GO TO 280
C
C  CIRCULAR/ELLIPTIC FUSELAGE - READ CROSS SECTIONAL AREAS/RADII
C
250   CONTINUE
      IF (LPRT.AND.READA) WRITE(6,610)
      IF (LPRT.AND.READR) WRITE(6,615)
      IF (LPRT.AND.READE) WRITE(6,680)
      DO 255 I=1,NFUSOR
255   FUSAZ(I,NFU)=0.0
      I1=-9
      I2=0
      DO 260 NI=1,NREC
      I1=I1+10
      I2=I2+10
      IF (READA) READ (5,480) (FUSARD(I,NFU),I=I1,I2)
      IF (READR) READ (5,480) (FUSRAD(I,NFU),I=I1,I2)
      IF (READE) READ (5,480) (FUSBY(I,NFU),I=I1,I2)
      IF (LPRT.AND.READA) WRITE(6,510) NFU,(FUSARD(I,NFU),I=I1,I2)
      IF (LPRT.AND.READR) WRITE(6,510) NFU,(FUSRAD(I,NFU),I=I1,I2)
      IF (LPRT.AND.READE) WRITE(6,510) NFU,(FUSBY(I,NFU),I=I1,I2)
260   CONTINUE
C
      IF (.NOT.READE) GO TO 268
      WRITE(6,690)
      DO 264 I1=1,NFUSOR,10
      I2=I1+9
      READ(5,480) (FUSAZ(I,NFU),I=I1,I2)
      IF (LPRT) WRITE(6,510) NFU,(FUSAZ(I,NFU),I=I1,I2)
264   CONTINUE
268   CONTINUE
      DO 270 I=1,NFUSOR
      IF (READA) FUSRAD(I,NFU)=SQRT(FUSARD(I,NFU)/PI)
      IF (READR) FUSARD(I,NFU)=PI*FUSRAD(I,NFU)**2
      IF (FUSAZ(I,NFU).LE.0.) FUSAZ(I,NFU)=FUSBY(I,NFU)
270   CONTINUE
280   CONTINUE
C8    WRITE (9) BLOCK
290   CONTINUE
C
C     POD GEOMETRY DUMMY READ STATEMENTS ------  ------------------------
C
      IF (J3.EQ.0) GO TO 330
      N=NPODOR
      NREC=(N+9)/10
      DO 320 NN=1,NP
      READ (5,470) ABCD
      DO 300 NI=1,NREC
      READ (5,470) ABCD
300   CONTINUE
```

```
      DO 310 M=1,NREC
      READ (5,470) ABCD
310   CONTINUE
320   CONTINUE
C
C     FINS (VERTICAL TAILS) ----------------------------------------
C
330   IF (J4.EQ.0) GO TO 380
      N=NFINOR
      DO 350 NN=1,NF
      READ (5,480) ((FINORG(NN,I,J),J=1,4),I=1,2)
      IF (LPRT) WRITE(6,620) NN,((FINORG(NN,I,J),J=1,4),I=1,2)
      READ (5,480) (XFIN(NN,I),I=1,N)
      IF (LPRT) WRITE(6,630) (XFIN(NN,I),I=1,N)
      READ (5,480) (FINORD(NN,1,J),J=1,N)
      IF (LPRT) WRITE(6,640) (FINORD(NN,1,J),J=1,N)
      DO 340 J=1,N
      FINCR(NN,J)=0.
      FINOR(NN,J)=FINORD(NN,1,J)
340   CONTINUE
350   CONTINUE
C
C     CHANGE FINS TO ACTUAL UNITS
C
      DO 370 LQ=1,NF
      DO 370 I=1,2
      J=3-I
      E=.01*FINORG(LQ,J,4)
      E2=FINORG(LQ,J,2)
      DO 360 K=1,NFINOR
      EE=FINORD(LQ,1,K)*E
      FINORD(LQ,J,K)=E2+EE
      FINX2(LQ,J,K)=E2-EE
      FINX3(LQ,J,K)=FINORG(LQ,J,1)+E*XFIN(LQ,K)
360   CONTINUE
370   CONTINUE
C8    WRITE (9) BLOCK
380   CONTINUE
C
C     CANARDS (HORIZONTAL TAILS) -----------------------------------
C
      IF (J5.EQ.0) GO TO 460
      N=IABS(NCANOR)
      DO 420 NN=1,NCAN
      READ (5,480) ((CANORG(NN,I,J),J=1,4),I=1,2)
      IF (LPRT) WRITE(6,510) NN,((CANORG(NN,I,J),J=1,4),I=1,2)
      READ (5,480) (XCAN(NN,I),I=1,N)
      IF (LPRT) WRITE(6,660) (XCAN(NN,I),I=1,N)
      READ (5,480) (CANORD(NN,1,J),J=1,N)
      IF (LPRT) WRITE(6,670) (CANORD(NN,1,J),J=1,N)
C
C     NCANOR POSITIVE INDICATES SYMMETRICAL ORDINATES
C     NCANOR NEGATIVE INDICATES UPPER AND LOWER ORDINATES ARE GIVEN
C
      IF (NCANOR.LT.0) GO TO 400
      DO 390 J=1,N
      CANCR(NN,J)=0.
      CANOR(NN,J)=CANORD(NN,1,J)
      CANOR1(NN,1,J)=CANORD(NN,1,J)
390   CONTINUE
      GO TO 420
400   CONTINUE
      READ (5,480) (CANOR1(NN,1,J),J=1,N)
```

```
      IF (LPRT) WRITE(6,670) (CANOR1(NN,1,J),J=1,N)
      DO 410 J=1,N
      CANOR(NN,J)=(CANORD(NN,1,J)+CANOR1(NN,1,J))/2.
      CANCR(NN,J)=(CANORD(NN,1,J)-CANOR1(NN,1,J))/2.
410   CONTINUE
420   CONTINUE
C
C     CHANGE CANARD TO ACTUAL UNITS
C
      DO 450 NN=1,NCAN
      DO 440 K=1,2
      I=3-K
      E=.01*CANORG(NN,I,4)
      E3=CANORG(NN,I,3)
      DO 430 J=1,N
      CANORD(NN,I,J)=E*CANORD(NN,1,J)+E3
      CANOR1(NN,I,J)=-E*CANOR1(NN,1,J)+E3
      CANORX(NN,I,J)=CANORG(NN,I,1)+E*XCAN(NN,J)
430   CONTINUE
440   CONTINUE
450   CONTINUE
C8    WRITE (9) BLOCK
460   CONTINUE
      REWIND 9
      RETURN
C
470   FORMAT (8A10)
480   FORMAT (10F7.0)
490   FORMAT(///10X,26HVEHICLE GEOMETRY DEFINTION,74X,12H** CONFIG **
     *    ,/5X,33HREFERENCE AREA (J0.GT.0)    REFA=,G13.6)
500   FORMAT(//5X,45H    XAF = WING ORDINATES FOR AIRFOIL (% CHORD)
     *    ,10H (J1.NE.0))
510   FORMAT(I5,10F10.4)
520   FORMAT(/5X,42HWAFORG - WING AIRFOIL LEADING EDGE + CHORD
     *    /4X,1HI,7X,1HX,9X,1HY,9X,1HZ,5X,5HCHORD)
540   FORMAT(/5X,30H TZORD - WING CAMBER, Z VS XAF)
550   FORMAT(/5X,45HWAFORD - WING AIRFOIL ORDINATE (+SYM,-UP/LOW)
     *    ,9H  NWAFOR=,I3)
570   FORMAT(//5H  NFU,5X,26HXFUS - FUSELAGE X-STATIONS)
580   FORMAT(/5H  NFU,5X,37HZFUS - FUSELAGE Z-CAMBER VS XFUS FOR
     *    ,16HCIRCULAR SECTION)
590   FORMAT(/5H   JX,5X,42HY - COORDINATE ARBITRARY FUSELAGE SECTION
     1    ,6H(SFUS))
600   FORMAT(/5H   JX,5X,42HZ - COORDINATE ARBITRARY FUSELAGE SECTION
     1    ,6H(SFUS))
610   FORMAT(/5X,45HFUSARD - CIRCULAR FUSELAGE CROSS SECTION AREA)
615   FORMAT(/5X,32HFUSRAD - CIRCULAR FUSELAGE RADII)
620   FORMAT(//5X,38HFINORG - VERTICAL FIN AIRFOIL ORIGION#
     *    ,5X,8HFIN SEG=,I3,/10X,1HX,9X,1HY,9X,1HZ,5X,5HCHORD
     *    ,5H  IN ,4F10.3,5H  OUT,4F10.3)
630   FORMAT(/5X,40H  XFIN - X-STATION FIN AIRFOIL (% CHORD),/10F10.4)
640   FORMAT(/5X,40HFINORD - AIRFOIL ORDINATES VS XFIN (SYM),/10F10.4)
650   FORMAT(//5X,41HCANORG - HORIZONTAL TAIL AIRFOIL ORIGION#
     *    ,5X,9HTAIL SEG=,I3,/10X,1HX,9X,1HY,9X,1HZ,5X,5HCHORD
     *    ,5H  IN ,4F10.3,5H  OUT,4F10.3)
660   FORMAT(/5X,41H  XCAN - X-STATION TAIL AIRFOIL (% CHORD),/10F10.4)
670   FORMAT(/5X,41HCANORD - AIRFOIL ORDINATES VS XCAN (SYM),/10F10.4)
680   FORMAT(/5H  NFU,5X,41HFUSAY - ELLIPTIC FUSELAGE SEMI-MAJOR AXES)
690   FORMAT(/5H  NFU,5X,41HFUSAZ - ELLIPTIC FUSELAGE SEMI-MINOR AXES)
      END
```

```
      SUBROUTINE CUBIC2(X,Y,D,C,J)
C
C   FIT A CUBIC TO TWO POINTS GIVEN THE SLOPE AT EACH POINT
C
      DIMENSION X(2),Y(2),D(2),C(4)
      X2=X(2)
      B=X(1)-X2
      IF (B.NE.0.) GO TO 20
10    J=3
      RETURN
20    A=(Y(1)-Y(2))/B
      E=X(1)+X2
      C(4)=(D(1)+D(2)-A-A)/B/B
      C(3)=(A-D(2))/B-C(4)*(E+X2)
      C(2)=A-E*C(3)-C(4)*(E*X2+X(1)**2)
      C(1)=Y(2)-X2*(C(2)+X2*(C(3)+X2*C(4)))
      J=1
      RETURN
      END
```

```
      COMPLEX FUNCTION DBLU(Z)
C
C     THIS FUNCTION SUBROUTINE CALCULATES THE INTERMEDIATE TRANSFORM
C     VARIABLE W FOR THE CONFORMAL TRANSFORMATION OF AN ELLIPTICAL
C     BODY WITH WINGS
C
      COMMON/COM1/A2,B2,R2
      COMMON/COM3/ZR,ZI
      COMMON/COM5/DWDZ
      COMMON/COM6/W2,W
C
      COMPLEX Z,Z2,DWDZ,W,W2,WW
C
      Z2=Z*Z
      ZR=REAL(Z)
      ZI=AIMAG(Z)
      IF(ZR.NE.0.0) ZR=ZR/ABS(ZR)
      IF(ZI.NE.0.0) ZI=ZI/ABS(ZI)
      Z2=Z2-A2+B2
      Y=AIMAG(Z2)
      AY=1.0
      IF(Y.LT.0.0) AY=-1.0
      AYZ=1.0
      IF(ZI.LT.0.0) AYZ=-1.0
      Z2=CSQRT(Z2)*AY*AYZ
      IF((ABS(ZI).LE.0.0).AND.(REAL(Z).LT.0.0)) Z2=CMPLX(-REAL(Z2),
     1    AIMAG(Z2))
      DWDZ=0.5*(1.0+Z/Z2)
      WW=0.5*(Z+Z2)
      W2=1.0/WW/WW
      DBLU=WW
      RETURN
      END
```

```
      SUBROUTINE DERIV(X,Y,N,NDA,DA,FD)
C
C     FIT A CHAIN OF CUBIC CURVES THROUGH A SET OF N POINTS HAVING
C     CONTINUOUS FIRST AND SECOND DERIVATIVES AT THE INTERMEDIATE POINTS
C     AND SPECIFIED FIRST OR SECOND DERIVATIVE AT THE END POINTS
C
      COMMON/COEF/C(4,50),Z1(200)
      DIMENSION X(1),Y(1),FD(1)
      CALL SCAMP4(X,Y,N,NDA,-1,DA,0.,C,FD,0)
      RETURN
      END
```

```
      FUNCTION DERIV1(X1,Y1,N)
C
C     FIND THE FIRST DERIVATIVE OF THE QUADRATIC THROUGH THREE GIVEN
C     POINTS AT A SPECIFIED ONE OF THESE POINTS. THIS PROVIDES A GOOD
C     APPROXIMATION TO THE SLOPE OF A FUNCTION AT A POINT, PARTICULARLY
C     IF THE OTHER TWO POINTS USED ARE NEARBY.
C
      DIMENSION X(3),Y(3),X1(3),Y1(3)
      EQUIVALENCE (S,K)
      DO 10 I=1,3
      X(I)=X1(I)
      Y(I)=Y1(I)
10    CONTINUE
      K=N
      E=Y(1)-Y(2)
      H=Y(1)-Y(3)
      A=X(1)-X(2)
      B=X(1)-X(3)
      C=A*(X(1)+X(2))
      DT=B*(X(1)+X(3))
      C3=(B*E-A*H)/(B*C-A*DT)
      C2=(E-C3*C)/A
      K1=IABS(K)
      DO 20 I=1,3
      IF (K1.EQ.I) GO TO 30
20    CONTINUE
      GO TO 40
30    S=X(K1)
40    DERIV1=C2+2.*C3*S
      RETURN
      END
```

```
      FUNCTION DERIV2(X,Y,XX)
C
C     FIND THE SECOND DERIVATIVE OF THE CUBIC THROUGH FOUR GIVEN POINTS
C     AT AN ARBITRARY POINT WHOSE X COORDINATE IS SPECIFIED
C
      DIMENSION X(4),Y(4)
      DERIV2=0.
      IF (X(4).EQ.X(3)) RETURN
      IF (X(4).EQ.X(2)) RETURN
      IF (X(4).EQ.X(1)) RETURN
      IF (X(3).EQ.X(2)) RETURN
```

```
      IF (X(3).EQ.X(1)) RETURN
      IF (X(2).EQ.X(1)) RETURN
      Q41=(Y(4)-Y(1))/(X(4)-X(1))
      Q31=(Y(3)-Y(1))/(X(3)-X(1))
      Q21=(Y(2)-Y(1))/(X(2)-X(1))
      E=(Q31-Q21)/(X(3)-X(2))
      D=((Q41-Q21)/(X(4)-X(2))-E)/(X(4)-X(3))
      C=E-D*(X(3)+X(2)+X(1))
      DERIV2=2.*(C+3.*D*XX)
      RETURN
      END
```

```
      SUBROUTINE DIAGIN
C
C   INVERT THE DIAGONAL BLOCKS OF THE MATRIX
C   FOR MATRIX PARTITIONS % 60X60  INVERTED DIAGONALS ARE ON TAPE10.
C
      COMMON /PARAM / NBODY,NWING,NTAIL,LRC,THK,XMACH,ALPHA,BETA,ALPHAC
     1    ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,IPRINT,NWTHK
     1    ,NWBLOK,NWROW(20),NBBLOK,NBROW(60)
      COMMON /POINT / D(60,60),ZW(2400)
C
      CALL CPUTIM(TIME,DT,1)
      REWIND 9
      REWIND 10
      NDIM=60
      IF (NBODY.EQ.0) GO TO 50
C
C   READ MATRICES AND INVERT DIAGONAL BLOCKS
C
      DO 40 NB=1,NBBLOK
      NROW=NBROW(NB)
      NCOL=NROW
      IF (NBODY.GT.NMAX) GO TO 20
C        IF NBODY)61, USE ENTIRE MATRIX ON TAPE9
      DO 10 I=1,NBODY
      READ (9) (D(I,J),J=1,NBODY)
10    CONTINUE
      GO TO 30
C        IF NBODY%60, USE DIAGONAL BLOCKS ON TAPE7
20    READ (7) D
30    CALL INVERT(D,NCOL,NDIM)
      WRITE (10) D
40    CONTINUE
C
C   READ WING MATRICES AND INVERT DIAGONAL BLOCKS ------------------------
C
50    CONTINUE
C*    IF (NWING.EQ.0) GO TO 140
C        IF NWING)61, READ PAST WING/BODY MATRICES AND USE ENTIRE MATRIX
C*130   CONTINUE
140   REWIND 10
      REWIND 9
      REWIND 7
      CALL CPUTIM(TIME,DT,1)
      WRITE(6,150) TIME,DT
150   FORMAT(/10X,14HEND DIAGIN,   TIME=,F10.4,5X,3HDT=,F10.4)
      RETURN
      END
```

```
      COMPLEX FUNCTION DSDZ(S)
      COMMON/COM2/SIG2,H2
      COMMON/COM5/DWDZ
      COMMON/COM4/G2,G1
      COMMON/COM6/W2,W
      COMPLEX W,W2,DWDZ,G1,G2
      DSDZ=0.5*(1.0-SIG2**2)*(1.0+G1/G2)*DWDZ
      RETURN
      END
```

```
      COMPLEX FUNCTION DZDS(S)
      COMMON/COM1/A2,B2,R2
      COMMON/COM2/SIG2,H2
      COMMON/COM6/W2,W
      COMPLEX W,S,W2,G1,S2,Z,Z2
      S2=S*S
      G1=0.5*(1.0-0.25*(A2-B2)**2)*(1.0-R2/S2)
      Z=S+R2/S
      Z2=Z*Z-4.0*SIG2
      Y=AIMAG(Z)
      YZ=AIMAG(Z2)
      AY=1.0
      AYZ=1.0
      IF(Y.LT.0.0) AY=-1.0
      IF(YZ.LT.0.0) AYZ=-1.0
      Z2=CSQRT(Z2)*AY*AYZ
      IF((ABS(Y).LE.0.0).AND.(REAL(Z).LT.0.0)) Z2=CMPLX(-REAL(Z2),
     1     AIMAG(Z2))
      DZDS=G1*(1.0+Z/Z2)
      RETURN
      END
```

```
      SUBROUTINE ELBDVT (VA,WA,XPT,YPT,ZPT,NBODY)
C
C  ROUTINE ELBDVT - ELLIPTICAL BODY NOSE SEPARATION VORTEX CALCULATION
C                   --         -  -                  -  -
C  THIS ROUTINE INTERPOLATES IN TABLES OF VORTEX STRENGTH AND LOCATION
C  VERSUS X-STATION TO COMPUTE THE VORTEX VELOCITIES AT BODY CONTROL
C  POINTS
C
      DIMENSION VA(1),WA(1),XPT(1),YPT(1),ZPT(1)
      DIMENSION G(10),VX(10),VY(10)
      DIMENSION YVRTX(10,10),ZVRTX(10,10),GX(10,10)
      COMMON /BVRTX / NVTX,NXVTX,XV(10),AV(10),BV(10)
      COMMON /JOPTNS/ IZ1(68),IPRT(5),IXZSYM
      LOGICAL LPRT,LPRT3
      IF (NVTX.LE.0)                          RETURN
      IF (NXVTX.LE.0)                         RETURN
      LPRT = IPRT(1).GT.0
      LPRT3 = IPRT(3).GT.0
C
C ---------------- VORTEX LOCATION AND STRENGTHS ----------------------
C      FIRST SUBSCRIPT = VORTEX NO.*   SECOND SUBSCRIPT = X-STATION
C
C  READ VORTEX (Y,Z) LOCATIONS AT EACH STATION BY VORTEX
C
```

```
      IF (LPRT) WRITE(6,190)
      DO 130 I=1,NVTX
      READ(5,180) (YVRTX(I,J),J=1,NXVTX)
      IF (LPRT) WRITE(6,220) I,(YVRTX(I,J),J=1,NXVTX)
      READ(5,180) (ZVRTX(I,J),J=1,NXVTX)
      IF (LPRT) WRITE(6,200) I,(ZVRTX(I,J),J=1,NXVTX)
      READ(5,180) (GX(I,J),J=1,NXVTX)
      IF (LPRT) WRITE(6,210) I,(GX(I,J),J=1,NXVTX)
130   CONTINUE
C
C  VORTEX INTERPOLATION SUMMARY TABLE
C
      WRITE(6,230)
      DO 135 I=1,NVTX
      WRITE(6,240) I
      WRITE(6,250) (J,XV(J),YVRTX(I,J),ZVRTX(I,J),BV(J),AV(J),GX(I,J)
     *    ,J=1,NXVTX)
135   CONTINUE
C
C  ---------------- LOOP ON BODY CONTROL POINTS ------------------------
C
      IF (LPRT3) WRITE(6,270)
      DO 170 I=1,NBODY
      VA(I) = 0.0
      WA(I) = 0.0
      IF (XPT(I).LT.XV(1)     ) GO TO 170
      IF (XPT(I).GT.XV(NXVTX)) GO TO 170
C
C  LOCATE X-CONTROL POINTS IN VORTEX TABLE
C
      DO 140 J=2,NXVTX
      IF (XPT(I).LE.XV(J)) GO TO 150
140   CONTINUE
      J = NXVTX
150   JM1 = J-1
      SLOPE = XV(J)-XV(JM1)
      IF (SLOPE.NE.0.) SLOPE=(XPT(I)-XV(JM1))/SLOPE
C
C  INTERPOLATE FOR STRENGTH AND LOCATION OF EACH VORTEX
C
      DO 160 K=1,NVTX
      G(K) = GX(K,JM1)+(GX(K,J)-GX(K,JM1))*SLOPE
      VX(K) = YVRTX(K,JM1)+(YVRTX(K,J)-YVRTX(K,JM1))*SLOPE
      VY(K) = ZVRTX(K,JM1)+(ZVRTX(K,J)-ZVRTX(K,JM1))*SLOPE
160   CONTINUE
C
C           BB IS HORIZONTAL AXIS AND  BL IS VERTICAL AXIS
C
      BL = AV(JM1)+(AV(J)-AV(JM1))*SLOPE
      BB = BV(JM1)+(BV(J)-BV(JM1))*SLOPE
C
C
C     DETERMINE Y AND Z COORDINATES OF POINT ON THE BODY SURFACE,
C     LYING ON THE SAME RADIUS AS POINT XPT,YPT,ZPT,THAT IS WITH THE
C     SAME POLAR ANGLE.
C
      THTP=ATAN2(ZPT(I),YPT(I))
      SINE=SIN(THTP)
      COSINE=COS(THTP)
      RAD=1.0/SQRT((COSINE/BB)**2+(SINE/BL)**2)
C
C     MOVE POINT OUT 1 PERCENT OF BODY RADIUS.
C
      RAD=1.01*RAD
```

```
      YSURF=RAD*COSINE
      ZSURF=RAD*SINE
C
C  COMPUTE VELOCITY COMPONENTS INDUCED BY THE SPECIFIED VORTICITY
C  AT THE POINTS CALCULATED ABOVE.
C
      CALL VVELS(NVTX,YSURF ,ZSURF ,VX,VY,G,RB,BL,VA(I),WA(I),0,35)
C
      IF (LPRT3) WRITE(6,260) I,XPT(I),YSURF ,ZSURF ,VA(I),WA(I),RB,BL
      IF (LPRT3) WRITE(6,265) (K,VX(K),VY(K),G(K),K=1,NVTX)
170   CONTINUE
      RETURN
180   FORMAT(10F7.5)
190   FORMAT(///,10X,26HVORTEX LOCATION AND STRENGTH,
     *   72X,12H** ELBOVT **)
200   FORMAT(/,5H   I=,I3,7H ZVRTX=,10F10.4)
210   FORMAT(/,5H   I=,I3,7H    GX=,10F10.4)
220   FORMAT(//5H   I=,I3,7H YVRTX=,10F10.4)
230   FORMAT(//10X,26HVORTEX INTERPOLATION TABLE)
240   FORMAT(/ 5X,6HVORTEX,I5,
     *   //5H STAT,7X,2HXV,5X,5HYVRTX,5X,5HZVRTX,8X,2HBY,8X,2HAZ
     *   ,5X,5HGAM/V/)
250   FORMAT(I5,F10.3,5F10.4)
260   FORMAT(6H     I=,I5,7H    XPT=,F10.4,7H YSURF=,F10.4,7H ZSURF=,F10.4
     * ,7H    VA=,F10.5,7H    WA=,F10.5,7H    RB=,F10.4,7H    BL=,F10.4)
265   FORMAT(6H    K=,I5,7H    VX=,F10.4,7H    VY=,F10.4,
     *   7H    G=,F10.4)
270   FORMAT(1H1,10X,43HVORTEX STRENGTHS AND VELOCITIES AFTER VVELS /)
      END
```

```
      SUBROUTINE FORMOM(NPAN,NPASS,ALFA,COMPT,TSTXCP)
C
C  CALCULATE THE FORCE AND MOMENT COEFFICIENTS ON THE BODY, WING,
C  FIN (VERTICAL TAIL) AND CANARD (HORIZONTAL TAIL)
C NOTE: AS USED IN PROGRAM WOYBOY, BODY ONLY IS TREATED.
C
      COMMON /JOPTNS/ IZ1(59),NVLIN
     *  ,MCPOUT,XSTART,XMLE,NXCPT,IPLOT(4),IPRT(5),IXZSYM
      COMMON /HEAD  / TITLE1(8),TITLE2(8)
      COMMON          DCN(600),DCM(600),DCT(600),ZS(600),SIND(600),
     1   COSD(600),CP(600),DUD(300),SINT(600),COST(600),GW(600),
     2   GH(600),DZTDX(600)
      COMMON /FORM  / CNW,CTW,CMW,CNB,CTB,CMB,CNS(20),CTS(20),CMS(20)
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1   ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,IPRINT,NWTHK
     1   ,NWBLOK,NWROW(20),NBBLOK,NBROW(60)
      COMMON /NEWCOM/ KJ,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,K4,K5
     1   ,KF(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT(20),XCPT(20)
      COMMON /SEG   / NSEG,NROW(20),NCOL(20),COSS(20),SINS(20)
     1   ,BTE(20),NAT(20),SPAN(20),XLEW(20),BLE(20),ZLEW(20),NPLT(60)
      COMMON /POINT / ARRAY(6000)
C
      DIMENSION XPT(600),YPT(600),ZPT(600),THET(600),DELTA(600),SGN(600)
     1   ,AREA(600),POLAR(600),CHD(20),XLE(600),          XC(30,20)
C
      EQUIVALENCE                    (CHD(1),DUD(1))
```

```
     1    ,(XPT(1),ARRAY(1)),           (YPT(1),ARRAY(601))
     2    ,(ZPT(1),ARRAY(1201)),        (THET(1),ARRAY(1801))
     3    ,(DELTA(1),ARRAY(2401)),      (XC(1,1),ARRAY(3001))
     4    ,(SGN(1),ARRAY(3601)),        (AREA(1),ARRAY(4801))
     5    ,(XLEC(1),ARRAY(5401)),       (POLAR(1),DZTDX(1))
      INTEGER COMPT
      LOGICAL LBC,LPLT,TSTXCP
      DATA RADDEG/0.0174532926/
C
C  NOTE THAT THE WING, CANARD, AND TAIL ARE ALL SEGMENTS OF THE WING
C  IN THIS SUBROUTINE
C
C  COMPT=1 INDICATES BODY FORCE AND MOMENT CALCULATION
C       =2 INDICATES WING FORCE AND MOMENT CALCULATION
C
C  NPASS=1 FOR THE BODY
C       =1 FOR THE WING UPPER AND LOWER SURFACES IF THE NON-PLANAR
C          BOUNDARY CONDITION OPTION IS SELECTED
C       =1 FOR THE WING UPPER SURFACE IF THE PLANAR BOUNDARY
C          CONDITION OPTION IS SELECTED
C       =2 FOR THE WING LOWER SURFACE IF THE PLANAR BOUNDARY
C          CONDITION OPTION IS SELECTED
C
C  TSTXCP=FALSE, COMPUTE FORCES FOR ALL PANELS
C        =TRUE , COMPUTE FORCE ONLY BETWEEN XSTART AND XWLE
C
      IF (TSTXCP .AND. XSTART.GE.XWLE)                        RETURN
      NPANL=NPAN
      IF (COMPT.EQ.1) XON=XC(1,1)
      CNB=0.
      CTB=0.
      CMB=0.
C
C     ALFA IS ALPHA SUB C IN RADS.
C
      SIAL=SIN(ALFA)
      COAL=COS(ALFA)
      WRITE (6,320) TITLE1,TITLE2
      WRITE (6,310)
      IF (.NOT.TSTXCP) WRITE (6,450)
      IF (      TSTXCP) WRITE(6,460) XSTART,XWLE
      WRITE (6,330) XMACH,ALPHAC,PHIR
      WRITE (6,350)
      DO 50 I=1,NPAN
      SGN(I)=1.
      SIND(I)=SIN(DELTA(I))
      COSD(I)=COS(DELTA(I))
      SINT(I)=SIN(THET(I))
      COST(I)=COS(THET(I))
50    CONTINUE
      CN=0.
      CT=0.
      CM=0.
      CYW=0.
      CLROLL=0.
      CNYAW=0.
      IP=0
C
C  CALCULATE THE FORCES AND MOMENT ACTING ON EACH PANEL AND SUM OVER
C  THE ENTIRE COMPONENT
C
      DO 160 I=1,NPANL
      IP=IP+1
```

```
      XP=XPT(I)
      YP=YPT(I)
      ZP=ZPT(I)
C
C  CHECK WHETHER TO COMPUTE FORCE BETWEEN XSTART AND XWLE ONLY.
C
      IF (.NOT.TSTXCP) GO TO 150
      DCN(I) = 0.
      DCT(I) = 0.
      DCM(I) = 0.
      IF (XP.LT.XSTART .OR. XP.GT.XWLE) GO TO 160
150   CONTINUE
      CNORM=-CP(I)*AREA(I)*SGN(I)
C
C  FORCE AND MOMENT SIGN CONVENTIONS,BODY COORDINATE SYSTEM.
C         CNORM  = POSITIVE OUTWARD NORMAL FORCE ON PANEL
C         CXB    = POSITIVE AFT
C         CYB    = POSITIVE TO RIGHT
C         CZB    = POSITIVE UP
C         CMB    = POSITIVE NOSE UP
C         CNYAW  = POSITIVE NOSE RIGHT VIEWING FORWARDS
C         CLROLL = POSITIVE CLOCKWISE VIEWING FORWARDS
C
      DCXB = -CNORM*SIND(I)
      DCYB = -CNORM*COSD(I)*SINT(I)
      DCZB =  CNORM*COSD(I)*COST(I)
      DCMB   = -DCZB*(XP-REFX)+DCXB*(ZP-REFZ)
      DCNYAW = -DCYB*(XP-REFX)+DCXB*YP
      DCLROL = -DCZB*YP         +DCYB*(ZP-REFZ)
      DCN(I) = DCZB
      DCT(I) = DCXB
      DCM(I) = DCMB
      XQ=XP
      YQ=YP
      ZQ=ZP
C
C  NONDIMENSIONALIZE BODY PANEL CONTROL POINT COORDINATES
C  X COORDINATES ARE DIVIDED BY THE BODY REFERENCE LENGTH
C  Y AND Z COORDINATES ARE DIVIDED BY THE BODY REFERENCE DIAMETER
C
      XQ=(XP-XON)/REFL
      YQ=YP/REFD
      ZQ=ZP/REFD
      THETP=ATAN2(ZP,YP)*57.29578
      IF (THETP.LT.0.0) THETP=THETP+360.0
      WRITE (6,360) IP,XP,YP,ZP,THETP,CP(I),DCXB,DCYB,DCZB,DCMB
     *   ,DCNYAW,DCLROL
      CN=CN+DCN(I)
      CT=CT+DCT(I)
      CM=CM+DCM(I)
      CYB = CYB+DCYB
      CNYAW = CNYAW+DCNYAW
      CLROLL = CLROLL+DCLROL
160   POLAR(I)=ATAN2(YP,-ZP)*57.29
C
C  PLOT CP VERSUS X AND POLAR ANGLE AROUND BODY
C
      IF (TSTXCP) GO TO 168
      LPLT=IPLOT(2).GT.0
      IF (.NOT.LPLT) GO TO 168
      NCUR=KFORX(1)-1
      NOP =KRADX(1)-1
      IF (KFUS.GT.1) NOP=NPANL
```

```
      IF (KFUS.GT.1) NCUR=1
      DO 164 I=1,NCUR
164   NPLT(I)=NOP
      CALL PLOTA2(XPT,CP,2,NPLT,NOP,NCUR,100,50)
      WRITE(6,500)
      CALL PLOTA2(POLAR,CP,2,NPLT,NOP,NCUR,100,50)
      WRITE(6,510)
168   CONTINUE
C
C  STORE BODY AND WING FORCES AND MOMENT
C
      CNB=CN
      CTB=CT
      CMB=CM
      WRITE (6,370)
      IF (.NOT.TSTXCP) WRITE (6,450)
      IF (     TSTXCP) WRITE(6,460) XSTART,XALE
C
C  COMPUTE NORMAL AND TANGENTIAL (AXIAL) FORCE, PITCHING MOMENT,
C  LIFT AND DRAG COEFFICIENTS, AND COMPONENT CENTER OF PRESSURE
C
C              CHECK FOR SYMMETRIC CONFIGURATION
      SYM = 2.0
      IF (IXZSYM.NE.0) SYM=1.0
      CN=SYM*CN/REFA
      CT=SYM*CT/REFA
      CM=SYM*CM/(REFA*REFD)
      CYB=CYB/REFA
      CNYAW=CNYAW/(REFA*REFD)
      CLROLL=CLROLL/(REFA*REFD)
C
C
      IF (IXZSYM.EQ.0) CYB=0.
      IF (IXZSYM.EQ.0) CLROLL=0.
      IF (IXZSYM.EQ.0) CNYAW=0.
C
C     TRANSFORM FORCES AND MOMENTS (EXCEPT ROLLING MOMENT) INTO
C     WIND-AXIS SYSTEM.
C
      PHI=PHIR*RADDEG
      SINPHI=SIN(PHI)
      COSPHI=COS(PHI)
C
      CL=CN*COSPHI*COAL-CYB*SINPHI*COAL-CT*SIAL
      CY=CN*SINPHI+CYB*COSPHI
      CD=CT*COAL-CYB*SIAL*SINPHI+CN*SIAL*COSPHI
C
      CMW=CM*COSPHI-CNYAW*SINPHI
      CNYAWW=CM*COAL*SINPHI+CNYAW*COAL*COSPHI-CLROLL*SIAL
C
C
C     DXN IS CENTER OF PRESSURE LOCATION MEASURED FROM NOSE TIP
C
      DXN=0.
      IF (CN.NE.0.) DXN=(-CM/CN)*REFD+REFX
      IF (COMPT.EQ.1) WRITE (6,390) REFA,REFD,REFL
      WRITE (6,400) REFX,REFZ
      WRITE (6,410) XMACH,ALPHAC,ALPHA,PHIR,BETA,CT,CYB,CN,CM,CNYAW
     *   ,CLROLL,DXN,CL,CY,CD,CMW,CNYAWW
      RETURN
310   FORMAT (//10X,40HINTEGRATION OF THE PRESSURE DISTRIBUTION
     *   ,60X,12H** FORMOM ** /)
320   FORMAT (1H1,9X,8A10/10X,8A10)
```

```
330    FORMAT (/10X,6HMACH =,F8.4,3X,7HALPHAC=,F8.4,4X,5HPHIR=,F8.4/)
350    FORMAT (3X,5HPOINT,7X,1HX,10X,1HY,10X,1HZ,6X,5HTHETP,8X,2HCP,9X,
      *   2HCX,9X,2HCY,9X,2HCZ,9X,2HCM,8X,3HCLM,8X,3HCLL/)
360    FORMAT (I7,11F11.5)
370    FORMAT (1H1,9X,18HTOTAL COEFFICIENTS/10X,18(1H-))
390    FORMAT (10X,5HREFA=,F14.4,3X,5HREFD=,F14.4,3X,5HREFL=,F14.4)
400    FORMAT (/10X,5HXM   =,F14.4,3X,5HZM   =,F14.4)
410    FORMAT (/8X,5HMACH=,F15.5/6X,7HALPHAC=,F15.5,7X,6HALPHA=,F15.5,
      *    /8X,5HPHIR=,F15.5,8X,5HBETA=,F15.5,/10X,3HCX=,F15.5
      *    ,/10X,3HCY=,F15.5,/10X,3HCZ=,F15.5,/10X,3HCM=,F15.5
      *    ,/9X,4HCLN=,F15.5,/9X,4HCLL=,F15.5,/9X,4HXCP=,F15.5,
      *    //10X,33HFOLLOWING ARE IN WIND AXIS SYSTEM,
      *     /10X,3HCL=,F15.5,/10X,3HCY=,F15.5,
      *     /10X,3HCD=,F15.5,/9X,4HCMW=,F15.5,
      *     /6X,7HCNYAWW=,F15.5,/)
450    FORMAT (10X,11HON THE BODY//)
460    FORMAT(10X,24HON THE BODY FROM XSTART=,F10.4,9H TO XWLE=,F10.4//)
500    FORMAT(/20X,11HCP VERSUS X)
510    FORMAT(/20X,24HCP VERSUS MERIDIAN ANGLE)
       END
```

```
      SUBROUTINE GEOM
CDC   OVERLAY (LWB,1,0)
CDC   PROGRAM GEOM
C
C   INPUT CONFIGURATION GEOMETRY AND COMPUTE PANELS
C
C  SPECIAL COMMENT CARDS STARTING WITH:
C    CB  - ELIMINATED FOR BODY PROGRAM VERSION ONLY
C    CNP - ELIMINATED FOR NON PLANAR PANEL ONLY
C
C  TAPE USAGE IN GEOM-
C    TAPE5:  GEOM,     READ INPUT
C
C    TAPE7:  GEOM,     REWIND
C            BODPAN,   WRITE  ARRAY      - SAVE BODY GEOMETRY
C
C    TAPE8:            NOT USED IN BODY VERSION
C    TAPE9:            NOT USED IN BODY VERSION
C
C    TAPE10: GEOM,     REWIND
C            NEWRAD,   WRITE XB,YB,ZB - FROM ARRAY
C            BODPAN,   REWIND
C                      READ  XB,YB,ZB - INTO BLOCK
C                      REWIND
C
      COMMON /JOPTNS/ IZ1(8)
     1   ,J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,NRADX(4),NFORX(4)
     2   ,NP,NPODOR,NF,NFINOR,NCAN,NCANOR,J2TEST,NW,    IZ2(25)
     3   ,NVLIN,NCPOUT,XSTART,XWLE,NWCPT,IPLOT(4),IPRT(5),IXZSYM
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1   ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /HEAD  / TITLE1(8),TITLE2(8)
      COMMON /SEG   / NSEG,NROW(20),NCOL(20),COSS(20),SINS(20)
     1   ,RTE(20),NWT(20),SPNW(20),XLEW(20),BLE(20),ZLEW(20),ZB(60)
      COMMON               BLOCK(7500)
      COMMON /NEWCOM/ K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,K4,K5
     1   ,KF(6),KAN(6),KFINOR(6),KANOR(6),KCL,NCPT,LOCPT(20),XCPT(20)
      COMMON /VELCOM/ NPOINT,NPART,IZ4(2),NMAX,EM,IPRINT,NWTHK
```

```
     1    ,NWBLOK,NWROW(20),NBBLOK,NBROW(60)
      COMMON/ITERAT/ITMAX,CCTEST
      COMMON /BVWTX / NVTX,NXVTX,XV(10),AV(10),BV(10)
C
      LOGICAL LBC,THK,TAIL,LPRT
C
      IF (INIT.EQ.1) GO TO 9
      DO 5 I=1,24
5     KF(I)=0
      DO 6 I=1,260
6     NROW(I)=0
9     INIT=1
C
C   LBC=.TRUE.,  FOR PLANAR BOUNDARY CONDITION ON WINGS (LINBC=1)
C   LBC=.FALSE., FOR NON-PLANAR BOUNDARY CONDITION (LINBC=0)
C   THK = .TRUE.,  FOR WINGS WITH THICKNESS AND NONPLANAR PANELING
C                         (ITHICK<>0)
CNP   LBC=.FALSE.
      LBC=.TRUE.
      THK=.FALSE.
      EM=-1.
      ALPHA = 0.0
      BETA  = 0.0
      IPRINT=0
      NCPT=0
      NBODY=0
      NWING=0
      NTAIL=0
      NSEG=0
      KOL=0
      REFB=1.
      REFC=1.
      REFD=1.
      REFL=1.
      REFX=0.
      REFZ=0.
      ITMAX=0
      CCTEST=0.
      REWIND 7
C8    REWIND 8
C8    REWIND 9
      REWIND 10
C
C    INPUT CONFIGURATION PARAMETERS
C
      READ (5,150) TITLE1
      IF (EOF(5).NE.0.)                                   STOP 20
10    WRITE (6,170) TITLE1
C
C   DEBUG PRINT CONTROL OPTIONS
      READ (5,180) IPRT,IXZSYM,IPLOT,NWCPT,NVTX,NXVTX,NCPOUT,NVLIN
      LPRT = IPRT(1).GT.0
      IF (LPRT) WRITE(6,220) IPRT,IXZSYM,IPLOT,NWCPT,NVTX,NXVTX,NCPOUT
     *    ,NVLIN
C
C   VORTEX CALCULATION PARAMETERS
      READ (5,160) XWLE,XSTART
      IF (LPRT) WRITE(6,290) XWLE,XSTART
C
C   GEOMETRY DEFINTION OPTIONS
      READ (5,180) J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,
     1    (NRADX(I),NFORX(I),I=1,4),NP,NPODOR,NF,NFINOR,NCAN,NCANOR
      IF (LPRT) WRITE(6,230) J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS
```

```
     1    ,NRADX,NFORX,NP,NPCDOR,NF,NFINOR,NCAN,NCANOR
C
C    INPUT DESCRIPTION AND INITIALIZATION
C    SET BOUNDARY CONDITION AND WING THICKNESS OPTIONS
C
 30     CALL CONFIG
CDC     CALL OVERLAY (LWB,1,1)
        READ (5,150) TITLE2
        IF (LPRT) WRITE(6,170) TITLE2
        READ (5,140) LINBC,ITHICK,IPRINT,LCPA,LCPB,LCPC,ITMAX,CCTEST
        IF (LPRT) WRITE(6,240)
       *   LINBC,ITHICK,IPRINT,LCPA,LCPB,LCPC,ITMAX,CCTEST
        IF (LINBC.GT.0) LBC=.TRUE.
        IF (LBC.AND.ITHICK.GT.0) THK=.TRUE.
C
C    INPUT REVISED CONFIGURATION PANELING DESCRIPTION CONTROL INTEGERS
C
        READ (5,180) K0,K1,K2,K3,K4,K5,K6,KWAF,KWAFOR,KFUS,
       1    (KRADX(I),KFORX(I),I=1,4)
        IF (LPRT) WRITE(6,250) K0,K1,K2,K3,K4,K5,K6,KWAF,KWAFOR,KFUS,
       1    KRADX,KFORX
        TAIL=.FALSE.
        IF (K4.GT.0.OR.K5.GT.0) TAIL=.TRUE.
        IF (TAIL)
       1   READ (5,180) (KF(I),KFINOR(I),I=1,6),(KAN(I),KANOR(I),I=1,6)
        IF (LPRT.AND.TAIL) WRITE(6,260) KF,KFINOR,KAN,KANOR
C
C840    READ (9) REFA
        IF (K0.EQ.0) GO TO 50
        READ (5,160) REFAR,REFB,REFC,REFD,REFL,REFX,REFZ
        IF (LPRT) WRITE (6,270) REFAR,REFB,REFC,REFD,REFL,REFX,REFZ
        IF (REFAR.NE.0.) REFA=REFAR
        IF (REFB.EQ.0.) REFB=1.
        IF (REFC.EQ.0.) REFC=1.
        IF (REFD.EQ.0.) REFD=1.
        IF (REFL.EQ.0.) REFL=1.
C
C   GENERATE GEOMETRY IN ORDER WING, V.TAIL, H.TAIL, BODY
C
50      CONTINUE
        IF (KRADX(1).LE.21) GO TO 70
        WRITE (6,200)
        STOP 200
70      CONTINUE
C
C   READ AND COMPUTE BODY VORTEX GEOMETRY REQUIRED ----------------------
C
        CALL READVX (NFUS,NFORX,LPRT)
C
C    REVISE BODY (FUSELAGE) MERIDIAN LINE SPACING, THEN
C    REVISE AXIAL PANEL SPACING ON BODY (FUSFLAGE) AND
C    COMPUTE NEW PANEL GEOMETRY
C
        CALL NEWRAD
        CALL BODPAN
CDC     CALL OVERLAY (LWB,1,4)
CDC     CALL OVERLAY (LWB,1,5)
C
C   WRITE CONTROL POINTS ON TAPE4 --------------------------------------
C   IF NCPOUT.GT.0, PRTCPT GENERATES CONTROL POINT FOR VPATHL
C   IF NCPOUT=2,    STOP AFTER WRITING POINTS
C
        IF (NCPOUT.GT.0) CALL PRTCPT(NBODY)
```

```
C
      CALL CPUTIM (TIME,DT,1)
      IF (IPRINT.LT.0) WRITE(6,210) TIME,DT
      RETURN
C
C
140   FORMAT (7I3,F7.0)
150   FORMAT (8A10)
160   FORMAT (10F7.0)
170   FORMAT (///5X,8A10,25X,12H** GEOM    **)
180   FORMAT (24I5)
200   FORMAT (1H0,46HERROR= BODY HAS MORE THAN 20 COLUMNS OF PANELS)
210   FORMAT(///10X,18HEND GEOM    ,  TIME=,F10.3,5X,3HDT=,F10.3)
220   FORMAT(//5X,52HADDITIONAL PRINT OPTIONS (IPPT) + XZ-PANEL SYMMETRY
     *  ,/43H     IN    GEOM VORTEX    VEL    SOLN  IXZSYM ,/6I7
     *  ,//5X,20HPLOT OPTIONS (IPLOT)
     *  ,/28H   GEOM     CP  U/V/W          ,/4I7
     *  ,//5X,26HVORTEX CALCULATION CONTROL
     *  ,/35H  NACPT   NVTX  NXVTX NCPOUT  NVLIN,/5I7)
230   FORMAT(//10X,37HJ-DATA CARDS REQUIRED (NO=0,YES.NE.0)
     *  ,//50H     REFA    WING   BODY    POD  V.FIN H.TAIL XY-SYM
     *  ,/49H      J0      J1      J2      J3      J4      J5     J6,/7I7
     *  ,//21H    WING GEOM:    NWAF=,I5,3X,7HNWAFOR=,I5,
     *  ,/21H    BODY GEOM:    NFUS=,I5,4X,6HNRADX=,4I5
     *  ,/30X,6HNFORX=,4I5
     *  ,/21H     POD GEOM:      NP=,I5,3X,7HNPODOR=,I5
     *  ,/21H   V.FIN GEOM:      NF=,I5,3X,7HNFINOR=,I5
     *  ,/21H  H.TAIL GEOM:    NCAN=,I5,3X,7HNCANOR=,I5)
240   FORMAT(//50H  LINHC  THICK IPRINT   LCPA   LCPB   LCPC  ITMAX
     *  ,7H CCTEST,/7I7,F10.5)
250   FORMAT(//10X,44HK-DATA CARDS, ADDITIONAL CARDS FOR PANELING
     *  ,//50H     REF    WING    BODY     N/A  V.FIN H.TAIL    N/A
     *  ,/50H      K0      K1      K2      K3      K4      K5     K6 ,/7I7
     *  ,//22H    WING PANEL:    KWAF=,I5,5X,7HKWAFOR=,I5,
     *  ,/22H    BODY PANEL:    KFUS=,I5,4X,6HKRADX=,4I5
     *  ,/31X,6HKFORX=,4I5)
260   FORMAT(14H  V.FIN PANEL:,16X,7H     KF=,6I5,/30X,7HKFINOR=,6I5
     *  ,/14H H.TAIL PANEL:,16X,7H    KAN=,6I5,/30X,7H KANOR=,6I5)
270   FORMAT(//10X,23HPANEL REFERENCE LENGTHS
     *  ,/4X,5HREFAR,5X,4HREFB,6X,4HREFC,6X,4HREFD,6X,4HREFL
     *  ,6X,4HREFX,6X,4HREFZ,/8F10.3)
290   FORMAT (/6X,4HXWLE,4X,6HXSTART ,/2F10.3)
      END
```

```
      SUBROUTINE INVERT(A,IA,NROWS)
C
C  MATRIX INVERSION --- GAUSS-JORDAN ELIMINATION WITHOUT PIVOTING
C
      DIMENSION IPIVOT(60),INDXR(60),INDXC(60),A(NROWS,NROWS)
      N=IA
      DO 10 J=1,N
      IPIVOT(J)=0
10    CONTINUE
      DO 100 I=1,N
      T=0.
      DO 30 J=1,N
      IF (IPIVOT(J).EQ.1) GO TO 30
      DO 20 K=1,N
      IF (IPIVOT(K).EQ.1) GO TO 20
```

```
      IF (.NOT.(ABS(A(J,K))-ABS(T).GT.0.)) GO TO 20
      IROW=J
      ICOL=K
      T=A(J,K)
20    CONTINUE
30    CONTINUE
      IPIVOT(ICOL)=IPIVOT(ICOL)+1
      IF (IROW.EQ.ICOL) GO TO 50
      DO 40 L=1,N
      T=A(IROW,L)
      A(IROW,L)=A(ICOL,L)
      A(ICOL,L)=T
40    CONTINUE
50    INDXR(I)=IROW
      INDXC(I)=ICOL
      PIVOT=A(ICOL,ICOL)
      IF (PIVOT.EQ.0.) GO TO 130
      A(ICOL,ICOL)=1.
      DO 70 L=1,N
      A(ICOL,L)=A(ICOL,L)/PIVOT
70    CONTINUE
      DO 90 L=1,N
      IF (L.EQ.ICOL) GO TO 90
      T=A(L,ICOL)
      A(L,ICOL)=0.
      DO 80 M=1,N
      A(L,M)=A(L,M)-A(ICOL,M)*T
80    CONTINUE
90    CONTINUE
100   CONTINUE
      DO 120 I=1,N
      L=N+1-I
      IF (INDXR(L).EQ.INDXC(L)) GO TO 120
      IROW=INDXR(L)
      ICOL=INDXC(L)
      DO 110 K=1,N
      T=A(K,IROW)
      A(K,IROW)=A(K,ICOL)
      A(K,ICOL)=T
110   CONTINUE
120   CONTINUE
      RETURN
130   WRITE (6,140)
      STOP
140   FORMAT (1H0,30HERROR - THE MATRIX IS SINGULAR)
      END
```

```
      SUBROUTINE ITRATE
C
C  SOLVE THE BOUNDARY CONDITION EQUATIONS BY AN ITERATIVE METHOD AND
C  DETERMINE THE STRENGTHS OF THE BODY SOURCES AND THE WING, FIN
C  (VERTICAL TAIL), AND CANARD (HORIZONTAL TAIL) VORTICES.
C
      COMMON /POINT / D(60,60),DNB(600),DNW(600),Z6(1200)
      COMMON          NW(600),NB(600),NT(600),A(600),RW(600),RB(600),
     1 Z7(2100),GW(600),GB(600),GT(600)
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1    ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,IPRINT,NWTHK
```

```
      1   ,NWBLOK,NWROW(20),NBBLOK,NBROW(60)
       COMMON /ITERAT/ ITMAX,CCTEST
       REAL NB,NW,NT
C
C   VARIABLE DEFINITIONS:
C         NW,NB - INPUT NORMAL VELOCITY , WING AND BODY
C         GW,GB - OUTPUT STRENGTH (WING AND BODY)
C         D     - DIAGONAL BLOCK MATRIX
C         RW,RB - RESIDUAL NORMAL VELOCITY COMPONENT
C         NT,GT - TEMPORARY VECTORS FOR LAST ITERATION
C
       IMAX=15
       IF (ITMAX.NE.0) IMAX=ITMAX
       EPS=1.E-3
       IF (CCTEST.NE.0.) EPS=CCTEST
       REWIND 9
C
C   INITIALIZE WING AND BODY SOLUTION
C
       IF (NBODY.EQ.0) GO TO 20
       DO 10 N=1,NBODY
       NT(N)=0.
       RB(N)=NB(N)
 10    CONTINUE
 20    CONTINUE
CB       IF (NWING.EQ.0) GO TO 40
CB       DO 30 N=1,NWING
CB       GT(N)=0.
CB       RW(N)=NW(N)
CB30     CONTINUE
C
C   START ITERATION ---------------------------------------------------
C
 40    DO 250 IT=1,IMAX
       CALL CPUTIM(TIME,DT,1)
       IF (IABS(IPRINT).GT.2) WRITE(6,390) IT,TIME,DT
       ITEST=0
       IB=0
       IW=0
       IF (NBODY.EQ.0) GO TO 80
C
C   COMPUTE BODY STRENGTHS FROM DIAGONAL BLOCKS - GB = D*RB
C
       JS=0
       NBLOK=NBBLOK
       DO 60 NN=1,NBLOK
       NROW=NBROW(NN)
       NCOL=NROW
       READ (10) D
       DO 50 I=1,NROW
       IB=IB+1
       GB(IB)=0.
       DO 50 J=1,NCOL
       JJ=J+JS
       GB(IB)=GB(IB)+D(I,J)*RB(JJ)
 50    CONTINUE
       JS=JS+NROW
 60    CONTINUE
C         BODY CONVERGENCE TEST
       IF (IT.EQ.1) GO TO 80
       DO 70 N=1,NBODY
       IF (ABS(GB(N)-NT(N)).GE.EPS) ITEST=1
       IF (ITEST.EQ.1) GO TO 80
```

```
70     CONTINUE
C
C  COMPUTE WING STRENGTHS FROM DIAGONAL BLOCKS - GW = D*RW
C
80     CONTINUE
C8       IW = 0
C8       IF (NWING.EQ.0) GO TO 120
C8       JS=0
C8       NBLOK=NWBLOK
C8       DO 100 NN=1,NBLOK
C8       NROW=NWROW(NN)
C8       NCOL=NROW
C8       READ (10) D
C8       DO 90 I=1,NROW
C8       IW=IW+1
C8       GW(IW)=0.
C8       DO 90 J=1,NCOL
C8       JJ=J+JS
C8       GW(IW)=GW(IW)+D(I,J)*RW(JJ)
C890      CONTINUE
C8       JS=JS+NROW
C8100     CONTINUE
C8C          WING CONVERGENCE TEST
C8       IF (IT.EQ.1) GO TO 120
C8       DO 110 N=1,NWING
C8       IF (ABS(GW(N)-GT(N)).GE.EPS) ITEST=1
C8       IF (ITEST.EQ.1) GO TO 120
C8110     CONTINUE
C
C  PRINT ITERATION INFORMATION  ------------------------------------------------
C
120    REWIND 10
       IF (IABS(IPRINT).LT.3) GO TO 130
       WRITE (6,360) IT
       IF (NBODY.GT.0) WRITE (6,370) NBODY,(GB(N),N=1,NBODY)
       IF (NWING.GT.0) WRITE (6,380) NWING,(GW(N),N=1,NWING)
130    IF (IABS(IPRINT).LT.4) GO TO 140
       IF (NBODY.GT.0) WRITE (6,290) NBODY,(RB(N),N=1,NBODY)
       IF (NWING.GT.0) WRITE (6,300) NWING,(RW(N),N=1,NWING)
140    IF (ITEST.EQ.0.AND.IT.NE.1) GO TO 260
       IF (IT.GE.IMAX) GO TO 270
C
C  COMPUTE CROSS INFLUENCE BETWEEN BLOCKS  -------------------------------------
C         BODY PANEL J ON BODY CONTROL POINT I
C
C8     IF (NBODY.EQ.0) GO TO 200
       DO 165 I=1,NBODY
       BT(I)=GB(I)
       DNB(I)=0.
       READ (9) (A(J),J=1,NBODY)
       IF (NBODY.LE.NMAX) GO TO 160
       DO 150 J=1,NBODY
       DNB(I)=DNB(I)+A(J)*GB(J)
150    CONTINUE
160    RB(I)=NB(I)-DNB(I)
165    CONTINUE
C         WING PANEL J ON BODY CONTROL POINT I
C8     IF (NWING.EQ.0) GO TO 200
C8240    CONTINUE
250    REWIND 9
C
C  PRINT ITERATION SUMMARY  ----------------------------------------------------
260    WRITE (6,310) IT,EPS
```

```
      GO TO 280
270   WRITE (6,320) IMAX,EPS
280   WRITE (6,330)
      IF (NBODY.GT.0) WRITE (6,370) NBODY,(NT(N),N=1,NBODY)
      IF (NWING.GT.0) WRITE (6,380) NWING,(GT(N),N=1,NWING)
      WRITE (6,340)
      IF (NBODY.GT.0) WRITE (6,370) NBODY,(GB(N),N=1,NBODY)
      IF (NWING.GT.0) WRITE (6,380) NWING,(GW(N),N=1,NWING)
      RETURN
290   FORMAT (2X,10HRB(N),N=1,,I3/(1X,10F10.5))
300   FORMAT (2X,10HRW(N),N=1,,I3/(1X,10F10.5))
310   FORMAT (1H0,29HTHE ITERATION CONVERGED AFTER,I4,2X,
     1 35HITERATIONS WITH A TEST CRITERION OF,F10.7)
320   FORMAT (1H0,36HTHE ITERATION DID NOT CONVERGE AFTER,I4,2X,
     1 35HITERATIONS WITH A TEST CRITERION OF,F10.7)
330   FORMAT (1H0,41HTHE SOLUTION AT THE PREVIOUS ITERATION IS)
340   FORMAT (1H0,40HTHE SOLUTION AT THE PRESENT ITERATION IS)
360   FORMAT (17H0ITERATION NUMBER,I4)
370   FORMAT (2X,10HGB(N),N=1,,I3/(1X,10F10.5))
380   FORMAT (2X,10HGW(N),N=1,,I3/(1X,10F10.5))
390   FORMAT(/10X,25HCPU TIME IN ITRATE AT IT=,I4
     *    ,5X,5HTIME=,F10.4,5X,3HDT=,F10.4)
      END
```

```
      SUBROUTINE MXOUT (PAR,VAL,A,N,M,LINS,IPOS,ISP,ND,MD)
C
C     ..................................................................
C
C        SUBROUTINE MXOUT
C
C     PURPOSE
C           PRODUCES AN OUTPUT LISTING OF ANY SIZED ARRAY ON
C           LOGICAL UNIT 6
C
C        USAGE
C           CALL MXOUT (PAR,VAL,A,N,M,LINS,IPOS,ISP,ND,MD)
C
C        DESCRIPTION OF PARAMETERS
C           PAR = ALPHANUMERIC  PARAMETER NAME,  8H--------
C           VAL = NUMERICAL VALUE OF PAR
C           A = NAME OF OUTPUT MATRIX
C           N = NUMBER OF ROWS IN A
C           M = NUMBER OF COLUMNS IN A
C           LINS = NUMBER OF PRINT LINES ON THE PAGE (USUALLY 60)
C           IPOS = NUMBER OF PRINT POSITIONS ACROSS THE PAGE (132)
C           ISP = LINE SPACING CODE, 1 SINGLE SPACE, 2 DOUBLE SPACE
C                 3 SINGLE SPACE, NEW PAGE, 4 DOUBLE SPACE, NEW PAGE
C           ND = N DIMENSIONED SIZE OF A
C           MD = M DIMENSIONED SIZE OF A
C
C        SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C           NONE
C
C        METHOD
C           THIS SUBROUTINE CREATES A STANDARD LISTING OF ANY
C           SIZED ARRAY WITH ANY STORAGE MODE, EACH PAGE IS HEADED WITH
C           THE CODE NUMBER, DIMENSION AND STORAGE MODE OF THE ARRAY,
C           EACH COLUMN AND ROW IS ALSO HEADED WITH ITS RESPECTIVE
C           NUMBER,
```

```
C
C     ------------------------------------------------------------------
C
      DIMENSION A(NO,MO)
CDC   DIMENSION PAR(2)
1     FORMAT(/  ,5X, A8,1XF7.3 ,4X,I3,5H ROWS,4X,I3,8H COLUMNS,
     *                     4X,4X,5HPART ,I2  )
2     FORMAT(1X,10HROW/COLUMN,10(1X,I3,8X))
3     FORMAT(1H )
4     FORMAT(1H ,I7,10G12.5)
5     FORMAT(1H0,I7,10G12.5)
6     FORMAT (1H1)
      J = 1
C
C        WRITE HEADING
C
      NEND = IPOS/12-1
      LEND = (LINS/(MOD(ISP-1,2)+1))-2
      IPAGE = 1
10    LSTRT = 1
20    IF (ISP.GE.3) WRITE (6,6)
      WRITE(6,1)PAR,VAL,N,M,IPAGE
      JNT = J+NEND-1
      IPAGE = IPAGE+1
31    IF (JNT-M) 33,33,32
32    JNT = M
33    CONTINUE
      WRITE(6,2)(JCUR,JCUR=J,JNT)
40    LTEND = LSTRT+LEND-1
      DO 80 L=LSTRT,LTEND
C
C        FORM OUTPUT ROW LINE
C
      DO 55 K=1,NEND
      KK = K+J-1
      JT = J+K-1
C
C        CHECK IF LAST COLUMN,  IF YES GO TO 60
C
      IF (JT-M) 55,60,60
55    CONTINUE
C
C        END OF LINE, NOW WRITE
C
60    IF (MOD(ISP-1,2)) 65,65,70
65    WRITE(6,4)L,(A(L,JM),JM=J,KK)
      GO TO 75
70    WRITE(6,5)L,(A(L,JM),JM=J,KK)
C
C        IF END OF ROWS, GO CHECK COLUMNS
C
75    IF (N-L) 85,85,80
80    CONTINUE
C
C        END OF PAGE, NOW CHECK FOR MORE OUTPUT
C
      LSTRT = LSTRT+LEND
      GO TO 20
C
C        END OF COLUMNS, THEN RETURN
85    IF(JT-M) 90,95,95
90    J = JT+1
      GO TO 10
95    RETURN
      END
```

```
      SUBROUTINE NEWRAD
CDC   OVERLAY (LAB,1,4)
CDC   PROGRAM NEWRAD
C
C  REVISE BODY (FUSELAGE) MERIDIAN LINE SPACING
C  BODY DIFFINATION OPTIONS FOR EACH SEGMENT:
C     J2TEST = 1, CIRCULAR FUSELAGE WITH NO BODY CAMBER
C            = 2, CIRCULAR FUSELAGE WITH BODY CAMBER
C            = 3, ARBITRARY Y,Z CROSS SECTION
C     KRADX  = 0, USE NRADX MERIDIAN ANGLES
C            < 0, READ KRADX METIDIAN ANGLES
C            > 0, GENERATE KRADX EQUAL SPACING MERIDIAN ANGLES
C                 TOTAL NUMBER OF ANLGES MUST BE LESS THAN 21.
C     IXZSYM = 0, SYMMETRIC GEOMETRY AND LOADS ASSUMED
C            = 1, GENERATE FULL SYMMETRIC CONFIGURATION
C            = -1, READ FULL CONFIGURATION (2KRADX-1 VALUES)
C
      COMMON /JOPTNS/ IZ1(8)
     1    ,J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,NRADX(4),NFORX(4)
     2    ,NP,NPODOR,NF,NFINOR,NCAN,NCANOR,J2TEST,NW
     3    ,IZ2(34),IPRT(5),IXZSYM
      COMMON             BLOCK(7500)
      COMMON /POINT / ARRAY(6000)
      COMMON /NEWCOM/ K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,K4,K5
     1    ,KF(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT(20),XCPT(20)
C
      DIMENSION XFUS(30,4),ZFUS(30,4),ZB(30,30),FUSRAD(30,4),
     1 SFUS(30,30,8),ANSIN(30),ANCOS(30),PHIN(30),PHIK(30),XB(30),
     2 YB(30,30),YF(30),ZF(30),FUSAZ(30,4)
C
      EQUIVALENCE  (XFUS(1,1),BLOCK(1)), (ZFUS(1,1),BLOCK(121))
     *   ,(SFUS(1,1,1),BLOCK(241)),         (FUSRAD(1,1),BLOCK(361))
     *   ,(FUSAZ(1,1),BLOCK(481))
      EQUIVALENCE  (YB(1,1),ARRAY(1)),     (ZB(1,1),ARRAY(1801))
     *   ,(XB(1),ARRAY(3601)),             (ANSIN(1),ARRAY(3661))
     *   ,(ANCOS(1),ARRAY(3691)),          (PHIN(1),ARRAY(3721))
     *   ,(PHIK(1),ARRAY(3751))
      LOGICAL NEWPHI
C
      XIN(X1,Y1,X2,Y2,Y)=X1+(X2-X1)*(Y-Y1)/(Y2-Y1)
C
      NEWPHI=.FALSE.
      EPS=1.E-6
      EP2=EPS*EPS
C        M = AXIAL STATION NUMBER
      M=0
      KFUS=NFUS
      KTEST=0
      RADD=1./57.2957795
      REWIND 10
      DO 110 NFU=1,NFUS
      NRAD=NRADX(NFU)
      KRAD=KRADX(NFU)
C
C   J2TEST = 3 AND KRAD = 0 INDICATE AN ARBITRARY FUSELAGE WITH
C   MERIDIAN LINES DEFINED BY NRAD IN THE GEOMETRY INPUT
C   KTEST = ARIBITRARY BODY INDICATOR: 0=CIR., 1=ARBITRARY
C
      IF (J2TEST.EQ.3.AND.KRAD.EQ.0) KTEST=1
      IF (KRAD.EQ.0)  KRAD=NRAD
      IF (KRAD.GT.20) GO TO 130
      IF (IXZSYM.NE.0 .AND. (2*KRAD-1).GT.30) GO TO 130
      IF (KRAD.LT.0) NEWPHI=.TRUE.
```

```
      KRAD=IABS(KRAD)
      KRADX(NFU)=KRAD
      NFUSQR=NFQRX(NFU)
      FANG=FLOAT(2*(KRAD-1))
      DELE=6.2831853/FANG
C
C   READ NEW MERIDIAN ANGLES FOR SYMMETRIC HALF
C
      IF (NEWPHI) READ (5,160) (PHIK(K),K=1,KRAD)
      IF (NEWPHI .AND. IPRT(1).GT.0) WRITE(6,190) NFU,(PHIK(K),K=1,KRAD)
      DO 30 K=1,KRAD
      IF (     NEWPHI) PHIR=PHIK(K)*RADD
      IF (.NOT.NEWPHI) PHIR=DELE*FLOAT(K-1)
20    PHIK(K)=PHIR
      IF (J2TEST.EQ.3) GO TO 30
      PHIR4=PHIR+4.712389
      ANSIN(K)=SIN(PHIR4)
      ANCOS(K)=COS(PHIR4)
30    CONTINUE
      KY=1+(NFU-1)*2
      KZ=KY+1
C
C  COMPUTE INTERMEDIATE VALUES AROUND CIRCUMFERENCE --------------------
C                N=AXIAL STATION INDEX
      DO 100 N=1,NFUSQR
      M=M+1
      IF (M.GT.60) GO TO 120
      XB(N)=XFUS(N,NFU)
      IF (J2TEST.EQ.3) GO TO 50
C
C  CASE 1, COMPUTE SECTION Y + Z COORDINATES FOR CIRCULAR/ELLIPTIC BODY
C
      BY=FUSRAD(N,NFU)
      AZ=FUSAZ(N,NFU)
      CAM=ZFUS(N,NFU)
      DO 40 K=1,KRAD
      RAD=0.0
      IF (BY.NE.0.)
     *   RAD=1.0/SQRT((ANCOS(K)/BY)**2+(ANSIN(K)/AZ)**2)
      YB(N,K)=RAD*ANCOS(K)
      ZB(N,K)=RAD*ANSIN(K)+CAM
40    CONTINUE
      GO TO 100
C
C  CASE2, COMPUTE SECTION Y AND Z ORDINATES FOR NONCIRCULAR BODY
C   BY LINEAR INTERPOLATION
C                K,NN=CIRUMFERENTIAL STATION INDICES
C
50    K1=2
      PHIN(1)=0.
      YB(N,1)=SFUS(1,N,KY)
      ZB(N,1)=SFUS(1,N,KZ)
      YF(1)=YB(N,1)
      ZF(1)=ZB(N,1)
      ZC=(SFUS(1,N,KZ)+SFUS(NRAD,N,KZ))/2.
      DO 90 NN=2,NRAD
      IF (KTEST.EQ.1) GO TO 80
      YF(NN)=SFUS(NN,N,KY)
      ZF(NN)=SFUS(NN,N,KZ)-ZC
      NM1=NN-1
      IF (YF(NN).EQ.0..AND.ZF(NN).EQ.0.) GO TO 80
      IF (ABS(YF(NN)).LE.EP2) YF(NN)=0.
      PHIN(NN)=ATAN2(YF(NN),-ZF(NN))
```

```
      DO 60 K=KI,KRAD
      IF (PHIK(K).GT.PHIN(NN)) GO TO 70
      YB(N,K)=XINT(YF(NM1),PHIN(NM1),YF(NN),PHIN(NN),PHIK(K))
      ZB(N,K)=XINT(ZF(NM1),PHIN(NM1),ZF(NN),PHIN(NN),PHIK(K))+ZC
60    CONTINUE
70    KI=K
      GO TO 90
C
C  CASE 3. USE INPUT Y,Z VALUES
C
80    YB(N,NN)=SFUS(NN,N,KY)
      ZB(N,NN)=SFUS(NN,N,KZ)
90    CONTINUE
100   CONTINUE
C
C  GENERATE SYMMETRIC HALF OF BODY FOR IXZSYM=1  ----------------------
C
      IF (IXZSYM.LE.0) GO TO 106
      DO 104 N=1,NFUSOR
      K=KRAD
      DO 104 I=2,KRAD
      K=K+1
      IK=KRAD-I+1
      YB(N,K)=-YB(N,IK)
      ZB(N,K)=ZB(N,IK)
104   CONTINUE
      KRAD=K
      KRADX(NFU)=KRAD
106   CONTINUE
      MAX=M
      WRITE (10) XB,YB,ZB
110   CONTINUE
      RETURN
120   WRITE (6,180)
      STOP 120
130   WRITE (6,170)
      STOP 130
160   FORMAT (10F7.0)
170   FORMAT (40H ERROR - BODY HAS MORE THAN 20 MERIDIANS
     *  ,70X,12H** NEWRAD **)
180   FORMAT (45H ERROR - BODY HAS MORE THAN 60 AXIAL STATIONS
     *  ,65X,12H** NEWRAD **)
190   FORMAT(7H   NFU=,I5,/7H  PHIK=,10G12.5,2(/7X,10G12.5))
      END
```

```
      SUBROUTINE PANEL(IP,IQ,J,K,L,NP,AP)
C
C  CALCULATE PANEL GEOMETRY (BASED ON THE HYPERSONIC ARBITRARY BODY
C  PROGRAM OF A. E. GENTRY)  FOR NON-PLANAR PANELS
C
      COMMON /POINT/ XPT(600),YPT(600),ZPT(600),THET(600),DELTA(600),
     1   XC(30,20),YC(30,20),ZC(30,20),DUM(1200)
      COMMON           Z1(6900),ZU(30,20)
      DIMENSION XIN(4),YIN(4),ZIN(4),XI(4),ETA(4)
      REAL NX,NY,NZ
C
C  REORDER THE PANEL CORNER POINTS TO CORRESPOND TO GENTRY CONVENTION
C
```

```
      EPS=1.E-6
      J1=J-1
      K1=K-1
      XIN(1)=XC(J1,K1)
      XIN(2)=XC(J,K1)
      XIN(3)=XC(J,K)
      XIN(4)=XC(J1,K)
      YIN(1)=YC(J1,K1)
      YIN(2)=YC(J,K1)
      YIN(3)=YC(J,K)
      YIN(4)=YC(J1,K)
      IF (L.EQ.1) GO TO 10
      ZIN(1)=ZC(J1,K1)
      ZIN(2)=ZC(J,K1)
      ZIN(3)=ZC(J,K)
      ZIN(4)=ZC(J1,K)
      GO TO 20
10    ZIN(1)=ZU(J1,K1)
      ZIN(2)=ZU(J,K1)
      ZIN(3)=ZU(J,K)
      ZIN(4)=ZU(J1,K)
C
C    FORM DIAGONAL VECTORS
C    FORM VECTOR CROSS PRODUCT, N = T2 X T1
C
20    T1X=XIN(3)-XIN(1)
      T2X=XIN(4)-XIN(2)
      IF (IP.EQ.1) T2X=-T2X
      T1Y=YIN(3)-YIN(1)
      T2Y=YIN(4)-YIN(2)
      IF (IP.EQ.1) T2Y=-T2Y
      T1Z=ZIN(3)-ZIN(1)
      T2Z=ZIN(4)-ZIN(2)
      IF (IP.EQ.1) T2Z=-T2Z
      NX=T2Y*T1Z-T1Y*T2Z
      NY=T1X*T2Z-T2X*T1Z
      NZ=T2X*T1Y-T1X*T2Y
      IF (ABS(NX).LE.EPS) NX=0.
      IF (ABS(NY).LE.EPS) NY=0.
      IF (ABS(NZ).LE.EPS) NZ=0.
      VN=SQRT(NX*NX+NY*NY+NZ*NZ)
      IF (VN.EQ.0.) GO TO 30
C
C    FORM UNIT NORMAL VECTOR, THEN COMPUTE AVERAGE POINT
C
      VNO=1./VN
      NX=NX*VNO
      NY=NY*VNO
      NZ=NZ*VNO
30    AVX=.25*(XIN(1)+XIN(2)+XIN(3)+XIN(4))
      AVY=.25*(YIN(1)+YIN(2)+YIN(3)+YIN(4))
      AVZ=.25*(ZIN(1)+ZIN(2)+ZIN(3)+ZIN(4))
C
C    COMPUTE PROJECTION DISTANCE
C
      D=NX*(AVX-XIN(1))+NY*(AVY-YIN(1))+NZ*(AVZ-ZIN(1))
      T=SQRT(T1X*T1X+T1Y*T1Y+T1Z*T1Z)
      IF (T.EQ.0.) GO TO 40
      TD=1./T
      T1X=T1X*TD
      T1Y=T1Y*TD
      T1Z=T1Z*TD
40    T2X=NY*T1Z-NZ*T1Y
```

```
      T2Y=NZ*T1X-NX*T1Z
      T2Z=NX*T1Y-NY*T1X
C
C   COMPUTE COORDINATES OF CORNER POINTS IN REFERENCE COORDINATE
C   SYSTEM
C   TRANSFORM CORNER POINT TO ELEMENT COORDINATE SYSTEM (XI,ETA)
C   WITH AVERAGE POINT AS ORIGIN
C
      DO 50 N=1,4
      XPA=XIN(N)+NX*D
      YPA=YIN(N)+NY*D
      ZPA=ZIN(N)+NZ*D
      D=-D
      XDIF=XPA-AVX
      YDIF=YPA-AVY
      ZDIF=ZPA-AVZ
      XI(N)=T1X*XDIF+T1Y*YDIF+T1Z*ZDIF
      ETA(N)=T2X*XDIF+T2Y*YDIF+T2Z*ZDIF
   50 CONTINUE
C
C   COMPUTE CENTROID
C   OBTAIN CORNER POINTS IN SYSTEM WITH CENTROID AS ORIGIN
C
      ETACK=ETA(2)-ETA(4)
      IF (ETACK.NE.0.) GO TO 60
      XI0=0.
      GO TO 70
   60 XI0=(XI(4)*(ETA(1)-ETA(2))+XI(2)*(ETA(4)-ETA(1)))/(3.*ETACK)
   70 ETA0=-ETA(1)/3.
      XI(1)=XI(1)-XI0
      XI(2)=XI(2)-XI0
      XI(3)=XI(3)-XI0
      XI(4)=XI(4)-XI0
      ETA(1)=ETA(1)-ETA0
      ETA(2)=ETA(2)-ETA0
      ETA(3)=ETA(3)-ETA0
      ETA(4)=ETA(4)-ETA0
C
C   TRANSFORM CENTROID TO REFERENCE COORDINATE SYSTEM
C
      XPT(NP)=AVX+T1X*XI0+T2X*ETA0
      YPT(NP)=AVY+T1Y*XI0+T2Y*ETA0
      ZPT(NP)=AVZ+T1Z*XI0+T2Z*ETA0
C
C   COMPUTE PANEL INCIDENCE AND INCLINATION ANGLE
C   COMPUTE PANEL AREA
C
      DELTA(NP)=0.
      THET(NP)=0.
      RN=SQRT(NY*NY+NZ*NZ)
      IF (L.EQ.0) GO TO 90
      SL=-1.
      IF (L.EQ.2) SL=1.
C
C  DELTA = ANGLE BETWEEN THE X-AXIS AND THE LINE OF INTERSECTION
C  WITH THE PANEL OF A PLANE PASSING THROUGH THE X-AXIS AND THE
C  PERPENDICULAR TO THE PANEL.
      IF (NX.NE.0.) DELTA(NP)=ATAN2(SL*NX,RN)
      SP=FLOAT(1-2*IP)
      IF (ABS(SP).LE.(EPS*EPS)) SP=0.
      IF (IS.EQ.1) GO TO 80
C
C  THET = ANGLE BETWEEN THE Y-AXIS AND THE LINE OF INTERSECTION
```

```
C   OF THE PANEL WITH THE Y-Z PLANE.
      IF (NY.NE.0.) THET(NP)=ATAN2(SP*NY,-SP*NZ)
      GO TO 100
80    IF (NZ.NE.0.) THET(NP)=ATAN2(-SP*NZ,SP*NY)
      GO TO 100
90    IF (NX.NE.0.) DELTA(NP)=ATAN2(-NX,RN)
      IF (NY.EQ.0..AND.NZ.EQ.0.) GO TO 100
      THET(NP)=ATAN2(-NY,NZ)
100   AP=.5*(XI(3)-XI(1))*ETACK
      IF (IP.EQ.1) AP=-AP
      RETURN
      END
```

```
      SUBROUTINE PARTIN
C
C   FOR WING-BODY COMBINATIONS, INVERT THE MATRIX PATITIONS (PROVIDED
C   THE ORDER DOES NOT EXCEED 60).
C
C   FOR ISOLATED WINGS OR BODIES, ALSO SOLVE THE BOUNDARY CONDITION
C   EQUATIONS AND DETERMINE THE WING VORTEX STRENGTHS OR BODY SOURCE
C   STRENGTHS.
C
      COMMON          NW(600),NB(600),NT(600),A(60,60),Z3(300),GW(600),
     1   GB(600),GT(600)
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1   ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /POINT / ARRAY(6000)
      DIMENSION D(60,60)
      EQUIVALENCE (D(1,1),ARRAY(1))
      REAL NW,NB,NT
C
      CALL CPUTIM(TIME,DT,1)
      NDIM=60
      REWIND 9
      NPANEL=NBODY+NWING
      IF (NWING.EQ.0.OR.NBODY.EQ.0) GO TO 50
C
C   INVERT DIAGONAL BLOCKS  ------------------------------------------------
C   INVERT BODY INFLUENCE MATRIX AND WRITE ON TAPE10
C
      REWIND 10
      DO 10 I=1,NBODY
      READ (9) (D(I,J),J=1,NBODY)
10    CONTINUE
      CALL INVERT(D,NBODY,NDIM)
      WRITE (10) D
C
C  READ PAST BODY/WING INFLUENCE MATRICES
CB       DO 20 I=1,NBODY
CB       READ (9) (D(I,J),J=1,NWING)
CB20     CONTINUE
CB       DO 30 I=1,NWING
CB       READ (9) (D(I,J),J=1,NBODY)
CB30     CONTINUE
CB       DO 40 I=1,NWING
CB       READ (9) (D(I,J),J=1,NWING)
CB40     CONTINUE
CB       CALL INVERT(D,NWING,NDIM)
CB       WRITE (10) D
CB       REWIND 9
```

```
      REWIND 10
      GO TO 100
C
C  SOLVE ENTIRE MATRIX IF NPANEL)61 - ONLY WINGS OR BODIES --------------
C
50    DO 60 I=1,NPANEL
      READ (9) (A(I,J),J=1,NPANEL)
60    CONTINUE
      REWIND 9
      CALL INVERT(A,NPANEL,NDIM)
C
C  SUBSTITUTE WING BOUNDARY CONDITION AND COMPUTE STRENGTHS - GW
C
      IF (NWING.EQ.0) GO TO 80
CB      DO 70 I=1,NWING
CB      GW(I)=0.
CB      DO 70 J=1,NWING
CB      GW(I)=GW(I)+A(I,J)*WW(J)
CB70    CONTINUE
      GO TO 100
C
C  SUBSTITUTE BODY BOUNDARY CONDITION AND COMPUTE STRENGTHS - GB
C
80    DO 90 I=1,NBODY
      GB(I)=0.
      DO 90 J=1,NBODY
      GB(I)=GB(I)+A(I,J)*WB(J)
90    CONTINUE
100   REWIND 9
      CALL CPUTIM(TIME,DT,1)
      WRITE(6,110) TIME,DT
110   FORMAT(/10X,18HEND PARTIN.  TIME=,F10.4,5X,3HDT=,F10.4)
      RETURN
      END
```

```
      SUBROUTINE PLOTA2 (X,Y,IOPT,NP,NDP,NC,LWID,LENG)
C*----------------------------------------------------------------------
C
C     SUBROUTINE PLOTA2
C
C     PURPOSE
C        ROUTINE TO GENERATE A SINGLE CHARACTER PLOT OF NC SIMULTANEOUS
C        CURVES OF  Y VERSUS X.  THE J-TH CURVE IS STORED COLUMNWISE IN
C        ARRAYS X(I,J) AND Y(I,J) AND MAY HAVE A VARIABLE NUMBER OF
C        POINTS, NP(J).
C
C
C     CALLING FORMAT
C        CALL PLOTA2 (X,Y,IOPT,NP,NDP,NC,LWID,LENG)
C
C     PARAMETERS
C        NAME    TYPE   I/O/S   DIM    DESCRIPTION
C
C        X,Y       R       I (NDP,NC) ORDINATE + ABSCISSA ARRAYS
C        IOPT      I       I     NONE  OPTION FOR TYPE OF PAGE SCALING
C                                      1. USER SPECIFIES SCALE LIMITS
C                                      2. INTERNAL AUTOMATIC BEST SCALING
C                                      3. AUTOMATIC TRUE SHAPE SCALING,  SES
C                                         RATIO: 0.6*LWID/LENG = XDIFF/YDIFF
C                                      4. USE MAX AND MIN VALUES OF DATA
```

```
C                                   5, INPUT XMAX,XMIN# AUTO Y-SCALING
C                                   6, INPUT YMAX,YMIN# AUTO X-SCALING
C         NP       I      I    NONE VECTOR OF NUMBER OF POINTS IN J*TH
C                                   CURVE,  IF NDP=1, NP IS ASSUMED EQUAL
C                                   TO 1 FOR ALL CURVES,
C         NDP      I      I    NONE FIRST DIMENSION OF ARRAYS *X,Y* IN
C                                   CALLING ROUTINE
C         NC       I      I    NONE NUMBER OF SIMULTANEOUS PLOTS,
C                                   IF NC>41, CHARACTER SET REPEATS,
C         LWID     I      I    NONE WIDTH OF PLOTTED REGIONS AT 10
C                                   CHARACTERS/INCH,  NORMALLY=100,
C                                   FOR CRT OR T.I. TERMINALS=50.
C                                   MAXIMUM DIMENSIONED = 100,
C         LENG     I      I    NONE NUMBER OF LINES IN PLOTTED REGION
C                                   NORMALLY=50 AT 6 LINES/INCH#
C                                   FOR 8.5" PAPER=40,
C
C     USER SUPPLIED COMMON BLOCKS
C        IOPT =1,5,6:  /BSCALE/ XMAX,XMIN,YMAX,YMIN
C
C     COMMON /BSCALE/
C        NAME    TYPE  I/O/S  DIM   DESCRIPTION
C
C         XMAX     R    I/O   NONE  MAXIMUM X SCALE VALUE ACROSS PAGE
C         XMIN     R    I/O   NONE  MINIMUM X SCALE VALUE ACROSS PAGE
C         YMAX     R    I/O   NONE  MAXIMUM Y SCALE VALUE AT TOP OF PAGE
C         YMIN     R    I/O   NONE  MINIMUM Y SCALE VALUE DOWN PAGE
C
C     EXTERNAL REFERENCES
C        PLOTA SUBROUTINES:  PLOTA7, PLOTA8
C
C     AUTHOR
C        JOSEPH MULLEN JR., NIELSEN ENGINEERING + RESEARCH, INC.
C        DATED: DECEMBER, 1976
C
C-----------------------------------------------------------------------
      DIMENSION X(NDP,NC),Y(NDP,NC),XPRINT(7),NP(NC),FMT(6)
      INTEGER SYMBOL(40)
      COMMON /BPLTA1/ NXPR,NYPR,IYAXIS,IXAXIS,IOFFX,IOFFY,LLINE
      COMMON /BPLTA2/ LINE(103)
      COMMON /BSCALE/ XMAX,XMIN,YMAX,YMIN
C
      DATA FMT/4H(7X ,4H,G16,4H.4,6,4H( 4X,4HG16.,4H4)) /
      DATA SYMBOL/1H*,1H+,1H-,1H.,1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7
     *,1H8,1H9,1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK,1HL,1HM
     *,1HN,1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ/
C
C  FIND MAX AND MIN OF X (ORDINATE) AND Y (ABSCISSA)
C
      NPJ = 1
      IF (IOPT.LT.1) IOPT=2
      IF (IOPT.EQ.1) GO TO 80
      IF (IOPT.EQ.5) GO TO 60
      XMAX = X(1,1)
      XMIN = X(1,1)
      DO 50 J=1,NC
      IF (NDP.GT.1) NPJ = NP(J)
      IF (NPJ.LT.1) GO TO 50
      DO 40 I=1,NPJ
      XMAX = AMAX1(X(I,J),XMAX)
40    XMIN = AMIN1(X(I,J),XMIN)
50    CONTINUE
      IF (IOPT.EQ.6) GO TO 80
```

```
C
60    YMAX = Y(1,1)
      YMIN = Y(1,1)
      DO 70 J=1,NC
      IF (NOP.GT.1) NPJ = NP(J)
      IF (NPJ.LT.1) GO TO 70
      DO 65 I=1,NPJ
      YMAX = AMAX1(Y(I,J),YMAX)
65    YMIN = AMIN1(Y(I,J),YMIN)
70    CONTINUE
C
C  DETERMINE SCALING AND ROUND OFF MAX AND MIN VALUES AND LOCATE
C  X- AND Y-AXES.
C
80    CALL PLOTAB(DX,DY,FMT,LWID,LENG,IOPT)
      NROWS = LENG+1
C
C  INITIALIZE PLOTING BANDWIDTH
C
      YLOW = YMAX-0.5*DY
      YMID = YMAX
      YUP = YMAX+0.5*DY
C
C  FORM UPPER BOUNDARY
C
      CALL PLOTA7 (LINE,1,1)
      WRITE(6,1) (LINE(I),I=1,LLINE)
      DO 230 L=1,NROWS
C
C  INITIALIZE BLANK ROW OR X-AXIS
C
      IF (L.NE.IXAXIS) CALL PLOTA7 (LINE,L-IOFFX,2)
      IF (L.EQ.IXAXIS) CALL PLOTA7 (LINE,L-IOFFX,1)
C
C  TEST FOR DATA IN L-TH ROW
C
      DO 210 J=1,NC
      JSYM = MOD(J-1,40)+1
      IF (NOP.GT.1) NPJ = NP(J)
      IF (NPJ.LT.1) GO TO 210
      DO 210 I=1,NPJ
      IF (Y(I,J).GT.YUP) GO TO 210
      IF (Y(I,J).LE.YLOW) GO TO 210
C
C  FIND X LOCATION OF POINT - CHECK IF WITHIN SIDE BOUNDS
C
      NDX = IFIX((X(I,J)-XMIN)/DX+0.5)+2
      IF (NDX.LE.1) GO TO 210
      IF (NDX.GE.LLINE) GO TO 210
      LINE(NDX) = SYMBOL(JSYM)
210   CONTINUE
C
C  PRINT ROW OF OUTPUT - TEST TO WRITE SCALES
C
      IMOD = MOD(L-IOFFX-1,NYPR)
      IF (IMOD.EQ.0) WRITE (6,2) YMID,(LINE(I),I=1,LLINE)
      IF (IMOD.NE.0) WRITE (6,3) (LINE(I),I=1,LLINE)
C
C  INCREMENT Y-STRIP; REDEFINE YLOW AND YUP
C
      YUP = YLOW
      YMID = YMID-DY
      IF (ABS(YMID/DY).LT.0.001) YMID=0.0
```

```
      YLOW = YLOW-DY
230   CONTINUE
C
C  FORM LOWER BOUNDARY
C
      CALL PLOTA7 (LINE,1,1)
      WRITE (6,3) (LINE(I),I=1,LLINE)
C
C  PRINT SCALES
C
      NXP = (LLINE-IOFFY)/NXPR+1
      XPRINT(1) = XMIN+DX*(IOFFY-2)
      DO 240 I=2,NXP
      XPRINT(I) = XPRINT(I-1)+DX*NXPR
      IF (ABS(XPRINT(I)/DX).LT.0.001) XPRINT(I)=0.0
240   CONTINUE
      WRITE(6,FMT) (XPRINT(I),I=1,NXP)
      RETURN
1     FORMAT (1H1,14X,103A1)
2     FORMAT (1X,G13.4,1X,103A1)
3     FORMAT (15X,103A1)
      END
```

```
      SUBROUTINE PLOTA3 (X,Y,Z,NP,NDP,NC,THETA,XCG,XP,YP,ISC)
C+-----------------------------------------------------------------------
C
C     SUBROUTINE PLOTA3
C
C     PURPOSE
C        ROUTINE TO PERFORM AN ARBITRARY ROTATION IN 3-SPACE OF (X,Y,Z)
C        DATA.  THE THREE DIMENSIONAL DATA IS REDUCE TO THE (X,Y)
C        PROJECTION, XP,YP.
C
C     CALLING FORMAT
C        CALL PLOTA3 (X,Y,Z,NP,NDP,NC,THETA,XCG,XP,YP,ISC)
C
C     PARAMETERS
C        NAME    TYPE  I/O/S  DIM     DESCRIPTION
C
C        X,Y,Z    R      I (NDP,NC) COORDINATE POINT ARRAYS
C        NP       I      I     NONE  VECTOR OF NUMBER OF POINTS IN J*TH
C                                    CURVE
C        NDP      I      I     NONE  FIRST DIMENSION OF ARRAY *X,Y,Z* IN
C                                    CALLING ROUTINE
C        NC       I      I     NONE  NUMBER OF CURVES TO BE TRANSFORMED
C        THETA    R      I     (3)   ROTATION ANGLES-THETAX,THETAY,THETAZ
C                                    (DEGREES).  ROTATIONS ARE PERFORMED
C                                    IN REVERSE ORDER.
C        XCG      R      I     (3)   LOCATION OF CENTER OF ROTATION
C                                    XCG = (XCG,YCG,ZCG)
C        XP,YP    R      O (NDP,NC) COORDINATES OF TRANSFORMED POINT
C                                    NOTE:  XP,YP MAY BE STORED  IN X,Y.
C        ISC      I      I     NONE  SCALING OPTION
C                                    1, AUTOMATIC SCALING
C                                    2, AUTOMATIC SCALING ON ONLY Z
C                                    3, NO SCALING OF COORDINATES
C                                    4, INPUT SCALING VECTOR - S
C                                    5, INPUT XMAX,....,ZMIN - SCALE X,Y,Z
C
```

```
C     USER SUPPLIED COMMON BLOCKS
C        ISC  =4,5:  /BSCAL2/ XMAX,XMIN,YMAX,YMIN,ZMAX,ZMIN,S(3)
C
C     COMMON /BSCAL2/
C        NAME    TYPE    I/O/S   DIM    DESCRIPTION
C
C        XMAX     R       I/O    NONE   MAXIMUM OF X DATA VALUES
C        XMIN     R       I/O    NONE   MINIMUM OF X DATA VALUES
C        YMAX     R       I/O    NONE   MAXIMUM OF Y DATA VALUES
C        YMIN     R       I/O    NONE   MINIMUM OF Y DATA VALUES
C        ZMAX     R       I/O    NONE   MAXIMUM OF Z DATA VALUES
C        ZMIN     R       I/O    NONE   MINIMUM OF Z DATA VALUES
C        S        R       I/O    NONE   VECTOR USED FOR RELATIVE SCALING
C                                       OF X,Y,Z COMPONENTS BEFORE ROTATION.
C
C     AUTHOR
C        JOSEPH MULLEN JR., NIELSEN ENGINEERING + RESEARCH, INC.
C        DATED: DECEMBER, 1976
C
C-----------------------------------------------------------------------
      DIMENSION X(NDP,NC),Y(NDP,NC),Z(NDP,NC),NP(NC)
      DIMENSION XP(NDP,NC),YP(NDP,NC),THETA(3),XCG(3)
      REAL RX(3,3),RY(3,3),RZ(3,3),R(3,3)
      COMMON /BSCAL2/XMAX,XMIN,YMAX,YMIN,ZMAX,ZMIN,S(3)
      DATA RX,RY,RZ/1.0,12*0.0,1.0,12*0.0,1.0/
      DATA RADDEG/0.0174532926/
      NPJ = 1
C
C  BUILD TRANSFORMATION MATRICES
C
      COSX = COS(THETA(1)*RADDEG)
      SINX = SIN(THETA(1)*RADDEG)
      COSY = COS(THETA(2)*RADDEG)
      SINY = SIN(THETA(2)*RADDEG)
      COSZ = COS(THETA(3)*RADDEG)
      SINZ = SIN(THETA(3)*RADDEG)
C
C DEFINE X-ROTATION
C
      RX(2,2) = COSX
      RX(2,3) = -SINX
      RX(3,2) = SINX
      RX(3,3) = COSX
C
C  DEFINE Y-ROTATION
C
      RY(1,1) = COSY
      RY(1,3) = SINY
      RY(3,1) = -SINY
      RY(3,3) = COSY
C
C  DEFINE Z-ROTATION
C
      RZ(1,1) = COSZ
      RZ(1,2) = -SINZ
      RZ(2,1) = SINZ
      RZ(2,2) = COSZ
C
C  OBTAIN SCALING - FIND MAXIMA AND MINIMA
C
      GO TO (100,100,150,160,130), ISC
100   XMAX = X(1,1)
      XMIN = X(1,1)
```

```
      YMAX = Y(1,1)
      YMIN = Y(1,1)
      ZMAX = Z(1,1)
      ZMIN = Z(1,1)
      DO 120 J=1,NC
      IF (NDP.GT.1) NPJ = NP(J)
      IF (NPJ.LT.1) GO TO 110
      DO 110 I=1,NPJ
      XMAX = AMAX1(XMAX,X(I,J))
      XMIN = AMIN1(XMIN,X(I,J))
      YMAX = AMAX1(YMAX,Y(I,J))
      YMIN = AMIN1(YMIN,Y(I,J))
      ZMAX = AMAX1(ZMAX,Z(I,J))
110   ZMIN = AMIN1(ZMIN,Z(I,J))
120   CONTINUE
      XDIFF = XMAX-XMIN
      YDIFF = YMAX-YMIN
      ZDIFF = ZMAX-ZMIN
C
C  CHOOSE SCALING - ISC=1,5, SCALE X,Y,Z
C
      GO TO (130,140,150,160,130),ISC
130   D = SQRT(XDIFF*XDIFF+YDIFF*YDIFF+ZDIFF*ZDIFF)
      S(1) = D/XDIFF
      S(2) = D/YDIFF
      S(3) = D/ZDIFF
      GO TO 160
C
C  ISC=2, SCALE ONLY Z.
C
140   D = SQRT(XDIFF*XDIFF+YDIFF*YDIFF)
      S(1) = 1.0
      S(2) = 1.0
      S(3) = D/ZDIFF
      GO TO 160
C
C  ISC=3, USE NO SCALING
C
150   S(1) = 1.0
      S(2) = 1.0
      S(3) = 1.0
C
C  COMPUTE GLOBAL TRANSFORMATION:   R = RZ*RY*RX*S
C
160   DO 180 J=1,3
      DO 180 I=1,3
      SUM = 0.0
      DO 170 K=1,3
      DO 170 L=1,3
170   SUM = SUM+RZ(I,K)*RY(K,L)*RX(L,J)
180   R(I,J) = SUM*S(J)
C
C  TRANSFORM COORDINATE VARIABLES:  XP = R*(X-XCG)
C
      DO 210 J=1,NC
      IF (NDP.GT.1) NPJ = NP(J)
      IF (NPJ.LT.1) GO TO 210
      DO 200 I=1,NPJ
      DX = X(I,J)-XCG(1)
      DY = Y(I,J)-XCG(2)
      DZ = Z(I,J)-XCG(3)
      XP(I,J) = R(1,1)*DX+R(1,2)*DY+R(1,3)*DZ
      YP(I,J) = R(2,1)*DX+R(2,2)*DY+R(2,3)*DZ
```

```
200   CONTINUE
210   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PLOTA5 (X,IEXP,IROUND)
C+-----------------------------------------------------------------------
C
C     SUBROUTINE PLOTA5
C
C     PURPOSE
C        ROUTINE TO ROUND OFF X
C
C     CALLING FORMAT
C        CALL PLOTA5 (X,IEXP,IROUND)
C
C     PARAMETERS
C        NAME    TYPE  I/O/S  DIM   DESCRIPTION
C
C        X        R     I/O   NONE  VALUE TRUNCATED AT GIVEN EXPONENT
C        IEXP     I      I    NONE  EXPONENT AT WHICH TRUNCATION OCCURS
C        IROUND   I      I    NONE  ROUND OFF INDICATOR:
C                                   ROUND UP (=+1), DOWN (=0)
C
C     AUTHOR
C        JOSEPH MULLEN JR., NIELSEN ENGINEERING + RESEARCH, INC.
C        DATED: DECEMBER, 1976
C
C     NOTES
C        CALLED BY PLOTA8, PLOTA9, PLOTI, + IRPLOT.
C
C-----------------------------------------------------------------------
      COMMON /OHUGA / IPR
      IF (X.LT.0.0) IR = IROUND-1
      IF (X.GE.0.0) IR = IROUND
      XS = X
      X = X/10.**IEXP
      IX = IFIX(X)
      IF (FLOAT(IABS(IX)).LT.ABS(X)) IX = IX+IR
      X = FLOAT(IX)*10.**IEXP
C
      IF (IPR.GT.0) WRITE(6,10) X,IEXP,IROUND,XS
10    FORMAT(23H PLOTA5 - DEBUG PRINT -,8H  X=OUT=,G12.5,
     *   7H  IEXP=,I5,8H IROUND=,I4,7H  X=IN=,G12.5)
      RETURN
      END
```

```
      SUBROUTINE PLOTA6 (DX,IEXP,NPRINT)
C+-----------------------------------------------------------------------
C
C     SUBROUTINE PLOTA6
C
C     PURPOSE
C        ROUTINE TO ROUND OFF SCALING TO NEAREST ACCEPTABLE PLOTTING
C        SCALE.
```

```
C
C      CALLING FORMAT
C         CALL PLOTA6 (DX,IEXP,NPRINT)
C
C      PARAMETERS
C         NAME    TYPE  I/O/S  DIM    DESCRIPTION
C
C         DX        R     I/O    NONE   VARIABLE TO ROUNDED OFF
C         IEXP      I      O     NONE   EXPONENT OF ROUNDED VARIABLE
C         NPRINT    I      O     NONE   NUMBER OF CHARACTERS BETWEEN LABELS
C
C      AUTHOR
C         JOSEPH MULLEN JR., NIELSEN ENGINEERING + RESEARCH, INC.
C         DATED: DECEMBER, 1976
C
C      NOTES
C         ARRAYS XSCL AND NPR IN THIS ROUTINE DETERMINE THE *ACCEPTABLE*
C         VALUES TO BE USED AS EVEN INCREMENTS IN PERFORMING SCALING.
C         CALLED BY PLOTA8, PLOTA9, PLOTI, + IRPLOT.
C
C-----------------------------------------------------------------------
      COMMON /DBUGA / IPR
      DIMENSION XSCL(6),NPR(6)
      DATA XSCL/2.,2.5,4.,5.,8.,10./
      DATA NPR /25,20,25,20,25,20/ ,NSCL/6/
      DATA DXSAVE /1.0/
C
      ABSX = ABS(DX)
      IF (ABSX.LE.0.) WRITE(6,10) DX
      IF (ABSX.LE.0.) ABSX=DXSAVE
      IF (ABSX.GT.0.) DXSAVE=ABSX
10    FORMAT(///5(2H *),45H WARNING - ILLEGAL DATA TO BE SCALED (PLOTA6)
     *      ,6H - DX=,G20.13,5(2H *))
C
C  DETERMINE EXPONENT OF DX
      AL = ALOG10(ABSX)
      IEXP = AL
      IF (ABSX.LT.1.) IEXP=IEXP-1
      AL = DX
C
C  SET ABSX BETWEEN 1 AND 10
      ABSX = ABSX/10.**IEXP
C
C  COMPARE WITH + LOCATE ACCEPTABLE SCALE
      DO 80 I=1,NSCL
      IF (ABSX.LE.XSCL(I)) GO TO 85
80    CONTINUE
      I = NSCL
85    ABSX = XSCL(I)
      NPRINT = NPR(I)
C
C  RETURN SCALED VALUES
      DX = SIGN(ABSX,DX)*10.**IEXP
      IF (IPR.GT.0) WRITE(6,12) DX,IEXP,NPRINT,I,AL
12    FORMAT(23H PLOTA6 - DEBUG PRINT -,8H DX-OUT=,G12.5,7H  IEXP=,I5,
     *   8H NPRINT=,I4,4H  I=,I3,7H DX-IN=,G12.5)
      RETURN
      END
```

```
      SUBROUTINE PLOTA7 (LINE,L,IOPT)
C+-----------------------------------------------------------------------
C
C     SUBROUTINE PLOTA7
C
C     PURPOSE
C        ROUTINE TO INITIALIZE A ROW OF PLOTTED OUTPUT.  THE ARRAY LINE
C        IS INITIALIZED WITH THE BORDER AND WITH X- AND Y-AXES.
C
C
C     CALLING FORMAT
C        CALL PLOTA7 (LINE,L,IOPT)
C
C     PARAMETERS
C        NAME    TYPE   I/O/S   DIM   DESCRIPTION
C
C        LINE      I      O     NONE  VECTOR CONTAINING LINE OF OUTPUT.
C        L         I      I     NONE  L*TH ROW OF OUTPUT
C        IOPT      I      I     NONE  OPTION: IOPT=1, INITIALIZE LINE AS
C                                     BOUNDARY OR AXIS
C                                     IOPT=2, INITIALIZE LINE AS BLANK
C
C     AUTHOR
C        JOSEPH MULLEN JR., NIELSEN ENGINEERING + RESEARCH, INC.
C        DATED: DECEMBER, 1976
C
C     NOTES
C        CALLED BY ARPLOT, PLOTA1, PLOTA2, + PLOTV2
C
C        THE DATA VARIABLES DASH, SLASH, BLANK, AND SLASHI DETERMINE THE
C        CHARACTERS WHICH MAKE UP THE PLOT BOARDER AND TICK MARKS.
C        THIS IS THE ONLY STATEMENT REQUIRED TO CHANGE THESE CHARACTER
C        REPRESENTATIONS.
C
C-----------------------------------------------------------------------
      INTEGER DASH,SLASH,BLANK,SLASHI,SYM,LINE(103)
      COMMON /BPLTA1/ NXPR,NYPR,IYAXIS,IXAXIS,IOFFX,IOFFY,LLINE
      DATA DASH,SLASH,BLANK,SLASHI/1H-,1HI,1H ,1HI/
CIBM  DATA DASH,SLASH,BLANK,SLASHI/1H-,1HI,1H ,1HI/
      SYM = SLASH
      LM1 = LLINE-1
C
C  SET Y-SCALE TICK MARKS
      IF (MOD(L-1,NYPR/2).EQ.0) SYM = DASH
      LINE(1) = SYM
      LINE (LLINE) = SYM
      IF (IOPT.EQ.2) GO TO 200
C
C  INITIALIZE BOUNDARY WITH X-SCALE TICK MARKS
      DO 70 J=2,LM1
70    LINE(J) = DASH
      IS = MOD(IOFFY,10)
      IF (IS.LE.0) IS=IS+10
      DO 80 J=IS,LM1,10
80    LINE(J) = SLASH
      DO 90 J=IOFFY,LM1,NXPR
90    LINE(J) = SLASHI
      RETURN
C
C  INITIALIZE BLANK ROW
200   DO 210 I=2,LM1
210   LINE(I) = BLANK
      IF (IYAXIS.GT.0) LINE(IYAXIS) = SYM
```

```
      RETURN
      END


      SUBROUTINE PLOTA8 (DX,DY,FMT,LWID,LENG,IOPT)
C+---------------------------------------------------------------------
C
C     SUBROUTINE PLOTA8
C
C     PURPOSE
C        ROUTINE TO SELECT SCALES, AND ROUND MAX AND MIN VALUES TO
C        ACCEPTABLE VALUES, AND LOCATE X- AND Y-AXES.
C
C
C     CALLING FORMAT
C        CALL PLOTA8 (DX,DY,FMT,LWID,LENG,IOPT)
C
C     PARAMETERS
C        NAME    TYPE  I/O/S   DIM    DESCRIPTION
C
C        DX        I    I/O    NONE   X DATA INCREMENT (OUTPUT)
C        DY        I    I/O    NONE   Y DATA INCREMENT (OUTPUT)
C        FMT       H    I/O    (6)    OBJECT TIME FORMAT FOR PRINTING
C                                     X-AXIS SCALES.
C        LWID      I     I     NONE   WIDTH OF PLOT (NO. OF CHARACTERS)
C        LENG      I     I     NONE   LENGTH OF PLOT (NO. OF CHARACTERS)
C        IOPT      I     I     NONE   OPTION FOR TYPE OF PAGE SCALING
C                                     1, USER SPECIFIES SCALE LIMITS
C                                     2, INTERNAL AUTOMATIC BEST SCALING
C                                     3, AUTOMATIC TRUE SHAPE SCALING, USES
C                                        RATIO: 0.6*LWID/LENG = XDIFF/YDIFF
C                                     4, USE MAX AND MIN VALUES OF DATA
C                                     5, INPUT XMAX,XMIN# AUTO Y-SCALING
C                                     6, INPUT YMAX,YMIN# AUTO X-SCALING
C
C     EXTERNAL REFERENCES
C        PLOTA SUBROUTINES:  PLOTA5, PLOTA6
C
C     AUTHOR
C        JOSEPH MULLEN JR., NIELSEN ENGINEERING + RESEARCH, INC.
C        DATED: DECEMBER, 1976
C
C     NOTES
C        1. PRODUCES SCALING CONSISTENT WITH ARPLOT, PLOTA1, PLOTA2, AND
C        PLOTV2.  VALUES COMPUTED BESIDES THE ARGUEMENT LIST ARE XMAX,
C        XMIN,YMAX,YMIN,NXPR,NYPR,IXAXIS,IYAXIS,IOFFX,IOFFY, AND FMT.
C        CALLED BY ARPLOT, PLOTA1, PLOTA2, + PLOTV2.
C
C        2. THE DATA VARIABLE *RATIO* IN THIS ROUTINE SETS THE CHARACTER
C        SIZE WIDTH-TO-HEIGHT RATIO FOR TRUE SHAPE SCALING.  TO CHANGE
C        SET *RATIO* EQUAL TO NO. OF CHARACTERS/INCH DOWN PAGE DIVIDED
C        BY NO. OF CHARACTERS /INCH ACROSS PAGE.
C
C----------------------------------------------------------------------
      DIMENSION DXI(4),DYI(4),IEXP(4),NPR(4),FMT(6),FMTX(27)
      COMMON /APLTA1/ NXPR,NYPR,IYAXIS,IXAXIS,IOFFX,IOFFY,LLINE
      COMMON /ASCALE/ XMAX,XMIN,YMAX,YMIN
      COMMON /DEBUGA / IPR
C
      DATA FMTX/ 4H(    ,4H(4X ,4H(7X ,4H(8X ,4H(9X ,4H(10X,4H(11X,4H(12X
     *   ,4H(13X,4H(14X,4H(15X,4H(16X,4H(17X,4H(18X,4H(19X,4H(20X
```

```
     *    ,4H(21X,4H(22X,4H(23X,4H(24X,4H(25X,4H(26X,4H(27X,4H(28X
     *    ,4H(29X,4H(30X,4H(31X/
      DATA RND,HALF/0.0001,0.5001/
C  DEFINE RATIO OF PRINTED CHARACTER WIDTH-TO-HEIGHT
      DATA RATIO/0.6/
C
C  TEST FOR ILLEGAL WIDTH AND LENGTH
C
      IF (LENG.LT.2) LENG=40
      IF (LWID.GT.100) LWID=100
      IF (LWID.LT.2)   LWID=100
      LLINE = LWID+3
C
C  DEBUG DATA CHECK OF INPUT
      IF (IPR.LT.0) IPR=0
      IF (IPR.GT.0) WRITE(6,10) IOPT,LWID,LENG,LLINE,XMAX,XMIN,YMAX,YMIN
10    FORMAT(23H PLOTAB - DEBUG PRINT -,7H  IOPT=,I5,7H  LWID=,I5,
     *  7H  LENG=,I5,7H LLINE=,I5,/10X,7H  XMAX=,G12.5,
     *  7H  XMIN=,G12.5,7H  YMAX=,G12.5,7H  YMIN=,G12.5)
C
      XDIFF = XMAX-XMIN
      YDIFF = YMAX-YMIN
      DX = XDIFF/LWID
      DY = YDIFF/LENG
      IXPAS = 0
      IYPAS = 0
C
C  BRANCH TO APPROPRIATE TYPE OF SCALING REQUESTED
C
230   GO TO (240,250,260,240,290,300),IOPT
C
C  IOPT=1,4, SPECIFY X-Y SCALE LIMITS
C
240   NXPR = 20
      NYPR = 10
      IF (ABS(RATIO*DY/DX-1.0).LT.0.01) NYPR=12
      GO TO 330
C
C  IOPT=2, COMPUTE AUTOMATIC SCALED LIMITS
C
250   CALL PLOTA6 (DX,IEXPX,NXPR)
      CALL PLOTA6 (DY,IEXPY,NYPR)
      NYPR = 10
      GO TO 310
C
C  IOPT=3, COMPUTE AUTOMATIC TRUE SHAPE SCALES
C
260   DYI(1) = DY
      DXI(2) = DY*RATIO
      DXI(3) = DX
      DYI(4) = DX/RATIO
      CALL PLOTA6(DYI(1),IEXP(1),NPR(1))
      CALL PLOTA6(DXI(2),IEXP(2),NPR(2))
      CALL PLOTA6(DXI(3),IEXP(3),NPR(3))
      CALL PLOTA6(DYI(4),IEXP(4),NPR(4))
      DXI(1) = DYI(1)*RATIO
      DYI(2) = DXI(2)/RATIO
      DYI(3) = DXI(3)/RATIO
      DXI(4) = DYI(4)*RATIO
      DXM = AMAX1(DXI(1),DXI(2),DXI(3),DXI(4))
      DO 270 I=1,4
      IF (DXI(I).LT.DX) GO TO 270
      IF (DYI(I).LT.DY) GO TO 270
```

```
      IF (DXI(I).GT.DXM) GO TO 270
      DXM = DXI(I)
      IBEST = I
270   CONTINUE
      DX = DXI(IBEST)
      DY = DYI(IBEST)
      IEXPX = IEXP(IBEST)
      IEXPY = IEXP(IBEST)
      IF (IBEST.LE.2) NXPR=20
      IF (IBEST.LE.2) NYPR=NPR(IBEST)/2
      IF (IBEST.GE.3) NXPR=NPR(IBEST)
      IF (IBEST.GE.3) NYPR=12
      GO TO 310
C
C  IOPT=5, SPECIFY X-SCALES, AUTOMATIC Y-SCALE SELECTION
C
290   NXPR = 20
      CALL PLOTA6(DY,IEXPY,NYPR)
      NYPR = 10
      GO TO 310
C
C  IOPT=6, SPECIFY Y-SCALES, AUTOMATIC X-SCALE SELECTION
C
300   NYPR = 10
      CALL PLOTA6(DX,IEXPX,NXPR)
      GO TO 320
C
C  RELOCATE AND ROUND OFF YMAX + XMIN
C   YMIN
310   IYPAS = IYPAS+1
      IF (IYPAS.GT.1) GO TO 315
      IYPAS = 1
      YMIN1 = YMIN-0.5*(DY*LENG-YDIFF)
      CALL PLOTA6 (YDIFF,IRND,NRND)
      CALL PLOTA5 (YMIN1,IRND,0)
315   IF (YMIN1.LE.0.) YMIN1=DY*FLOAT(IFIX(YMIN1/DY+SIGN(RND,YMIN1)))
C
C           CHECK FOR ZERO AS A POSSIBLE MINIMUM SCALE
      IF (ABS(YMIN/DY).LT.0.25) YMIN1=0.0
      IF (YMIN.GE.0.0) YMIN=AMAX1(YMIN1,0.0)
      IF (YMIN.LT.0.0) YMIN=YMIN1
      IF (IYPAS.GT.2) GO TO 320
C
C           CHECK FOR POSSIBLE LOSS OF DATA
      YMAX1 = YMIN+DY*LENG
      IF (YMAX1.LT.YMAX) DY=(YMAX-YMIN)/LENG
      IF (YMAX1.LT.YMAX) GO TO 250
      YMAX = YMIN+DY*LENG
C
C   XMIN
C
320   IF (IOPT.EQ.5) GO TO 330
      IXPAS = IXPAS+1
      IF (IXPAS.GT.1) GO TO 325
      IXPAS = 1
      XMIN1 = XMIN-0.5*(DX*LWID-XDIFF)
      CALL PLOTA6 (XDIFF,IRND,NRND)
      CALL PLOTA5 (XMIN1,IRND,0)
325   XMIN1=DX*FLOAT(IFIX(XMIN1/DX+SIGN(RND,XMIN1)))
C
C           CHECK FOR ZERO AS A POSSIBLE MINIMUM SCALE
      IF (ABS(XMIN/DX).LT.0.25) XMIN1=0.0
```

```
      IF (XMIN.GE.0.0) XMIN=AMAX1(XMIN1,0.0)
      IF (XMIN.GE.0.0 .AND. (XMAX-DX*L*ID).LE.0.0) XMIN=0.0
      IF (XMIN.LT.0.0) XMIN=XMIN1
      IF (IXPAS.GT.2) GO TO 330
C
C              CHECK FOR POSSIBLE LOSS OF DATA
      XMAX1 = XMIN+DX*L*ID
      IF (XMAX1.LT.XMAX) DX=(XMAX-XMIN)/L*ID
      IF (XMAX1.LT.XMAX) GO TO 230
      XMAX = XMIN+DX*L*ID
C
C  ESTABLISH LOCATION OF Y-AXIS, IF ANY
C
330   IF (XMIN.LT.0.0) IYAXIS=IFIX(ABS(XMIN/DX)+HALF)+2
      IF (XMIN.GE.0.0) IYAXIS=0
C
C  ESTABLISH LOCATION OF X-AXIS, IF ANY
C
      IF (YMIN.LT.0.0) IXAXIS=IFIX(ABS(YMAX/DY)+RND)+1
      IF ((YMIN.GE.0.0).OR.(YMAX.LE.0.0)) IXAXIS=0
C
C  COMPUTE Y-SCALE OFFSET OF ZERO OR BOTTOM OF PLOT
C
      IF (YMIN.LT.0.0) IOFFX = MOD(IXAXIS,NYPR)-1
      IF (YMIN.GE.0.0) IOFFX = MOD(LENG,NYPR)
C
C  COMPUTE X-SCALE OFFSET OF ZERO OR FIRST LABEL
C
      IF (XMIN.LT.0.) IOFFY=IYAXIS
      IF (XMIN.GE.0.) IOFFY=IFIX(-XMIN/DX-HALF)+2
      IOFFY = MOD(IOFFY,NXPR)
      IF (IOFFY.LT.2) IOFFY=IOFFY+NXPR
      IF ((IOPT.EQ.1).OR.(IOPT.EQ.5)) IOFFY=2
C
C  SET FORMAT, FMT, FOR X-AXIS
C
      IFMT = MAX0(3,IOFFY+1)
      FMT(1) = FMTX(IFMT)
      IF (NXPR.EQ.25) FMT(4)=FMTX(5)
      IF (NXPR.EQ.20) FMT(4)=FMTX(2)
      IF (NXPR.EQ.16) FMT(4)=FMTX(1)
C
      IF (IPR.LE.0) GO TO 999
      WRITE(6,12) XMAX,XMIN,DX,NXPR,IXAXIS,IOFFX,XMAX1,XMIN1,IXPAS
      WRITE(6,14) YMAX,YMIN,DY,NYPR,IYAXIS,IOFFY,YMAX1,YMIN1,IYPAS
      IF (IOPT.EQ.3) WRITE(6,16) DXI,DYI,IEXP,NPR,IREST
      WRITE(6,18) FMT
12    FORMAT(20H PLOTAB - X-SCALES =,7H  XMAX=,G12.5,7H  XMIN=,G12.5,
     *   7H    DX=,G12.5,7H  NXPR=,I5,8H IXAXIS=,I4,7H IOFFX=,I4,
     *   /20X,7H XMAX1=,G12.5,7H XMIN1=,G12.5,7H IXPAS=,I5)
14    FORMAT(20H PLOTAB - Y-SCALES =,7H  YMAX=,G12.5,7H  YMIN=,G12.5,
     *   7H    DY=,G12.5,7H  NYPR=,I5,8H IYAXIS=,I4,7H IOFFY=,I4,
     *   /20X,7H YMAX1=,G12.5,7H YMIN1=,G12.5,7H IYPAS=,I5)
16    FORMAT(20H PLOTAB - IOPT=3    =,6H  DXI=,4G12.5,
     *   /20X,6H  DYI=,4G12.5,/20X,6H IEXP=,4I12,
     *   /20X,6H  NPR=,4I12,10X,6HIREST=,I4)
18    FORMAT(20H PLOTAB - FORMAT    =,7H   FMT=,2X,6A4)
999   RETURN
      END
```

```
      SUBROUTINE PLOTG
C
C  ROUTINE TO PLOT PANEL GEOMETRY AND ROTATE CONFIGURATION FOR
C  PERSPECTIVE VIEWING
C
C  DATA STORAGE (TAPE7)I
C    1. ARRAY(6000) = WING/TAIL CORNER POINTS AND PANEL GEOMETRY
C    2. ARRAY(6000) = BODY CORNER POINTS
C
      DIMENSION ARRAY(6000),X(5,300),Y(5,300),Z(5,300)
     *    ,CHORD(600),SLOPE(600),XP(5,300),YP(5,300)
     *    ,NPLT(300),XCG(3),AROT(3),LINE(3000)
C
      COMMON /JOPTNS/ IZ1(8)
     1    ,J0,J1,J2,J3,J4,J5,J6,NWAF,NWAFOR,NFUS,NRADX(4),NFORX(4)
     2    ,NP,NPODOR,NF,NFINOR,NCAN,NCANOR,J2TEST,NW
     3    ,IZ2(34),IPRT(5),IXZSYM
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1    ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /POINT / XPT(600),YPT(600),ZPT(600),THET(600)
     *    ,DELTA(600),XC(30,20),YC(30,20),ZC(30,20),AREA(600),XLE(600)
      COMMON              BLOCK(7500)
      COMMON /NEWCOM/ K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,K4,K5
     1    ,KF(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT(20),XCPT(20)
      COMMON /SEG   / NSEG,NROW(20),NCOL(20),COSS(20),SINS(20)
     1    ,BT(20),NNT(20),BL(140)
      COMMON /BSIZE / XYPT(4),ITAPE
C
      EQUIVALENCE (ARRAY(1),XPT(1))
     *    ,(X(1),BLOCK(1)),      (Y(1),BLOCK(1501)),    (Z(1),BLOCK(3001))
     *    ,(XP(1),BLOCK(4501)), (YP(1),BLOCK(6001))
     *    ,(CHORD(1),AREA(1)),   (SLOPE(1),XLE(1))
     *    ,(XPT(1),LINE(1))
C
      DATA XCG,AROT/3*0.,  3*0./,  NPLT/300*5/
      DATA IOPT,NOP,LWID,LENG/3,5,100,50/
      DATA NLIN/3000/
      ITAPE=9
C
C  COPY WING PANEL POINTS IN TO (X,Y,Z)
C
      CALL CPUTIM(TIME,DT,1)
      REWIND 7
      JP = 0
      IF (K1.EQ.0 .AND. K4.EQ.0 .AND. K5.EQ.0) GO TO 150
      READ (7) ARRAY,CHORD,SLOPE
      ONE = 1.
      CALL MXOUT (8H XC=WING,ONE,XC,30,20,60,132,1,30,20)
C     CALL MXOUT (8H YC=WING,ONE,YC,30,20,60,132,1,30,20)
C     CALL MXOUT (8H ZC=WING,ONE,ZC,30,20,60,132,1,30,20)
C
C  DEFINE CLOSED CURVE AROUND BOUNDARY OF PANEL
C  POINTS ARE ACCESSED IN THE FOLLOWING ORDER
C    1 = (J-1,K-1)#       3 = (J-1,K)
C    2 = (J  ,K-1)#       4 = (J  ,K)
C  CURVE IS DRAWN IN FOLLOWING ORDER:  (1,2,4,3,1)
C
      IF (NSEG.EQ.0) GO TO 150
      L = 1
      DO 140 N=1,NSEG
      NR = NROW(N)
      NC = NCOL(N)
C
```

```
      DO 130 K=2,NC
      L = L+1
      KM1 = L-1
C
      DO  120 J=2,NR
      JM1 = J-1
      JP = JP+1
C  1ST CORNER
      X(1,JP) = XC(JM1,KM1)
      Y(1,JP) = YC(JM1,KM1)
      Z(1,JP) = ZC(JM1,KM1)
C  2ND CORNER
      X(2,JP) = XC(J,KM1)
      Y(2,JP) = YC(J,KM1)
      Z(2,JP) = ZC(J,KM1)
C  3RD CORNER
      X(3,JP) = XC(J,K)
      Y(3,JP) = YC(J,K)
      Z(3,JP) = ZC(J,K)
C  4TH CORNER
      X(4,JP) = XC(JM1,K)
      Y(4,JP) = YC(JM1,K)
      Z(4,JP) = ZC(JM1,K)
C  5TH CORNER  - CLOSE CURVE
      X(5,JP) = XC(JM1,KM1)
      Y(5,JP) = YC(JM1,KM1)
      Z(5,JP) = ZC(JM1,KM1)
      IF (JP.GE.300) GO TO 250
120   CONTINUE
130   CONTINUE
140   CONTINUE
C
C  READ BODY PANEL DATA FOR CORNER POINTS (XC,YC,ZC) -----------------
C
150   IF (NFUS.EQ.0) GO TO 250
      READ (7) ARRAY
      TWO = 2.
C     CALL MXOUT (8H XC-BODY,TWO,XC,30,20,60,132,1,30,20)
C     CALL MXOUT (8H YC-BODY,TWO,YC,30,20,60,132,1,30,20)
C     CALL MXOUT (8H ZC-BODY,TWO,ZC,30,20,60,132,1,30,20)
C
C  COPY BODY CORNER POINTS INTO CURVES
C
      L = 1
      DO 240 IFUS=1,NFUS
      NC = KRADX(IFUS)
      NR = KFORX(IFUS)
C
      DO 230 K=2,NC
      L = L+1
      KM1 = L-1
C
      DO 220 J=2,NR
      JP = JP+1
      JM1 = J-1
C  1ST CORNER
      X(1,JP) = XC(JM1,KM1)
      Y(1,JP) = YC(JM1,KM1)
      Z(1,JP) = ZC(JM1,KM1)
C  2ND CORNER
      X(2,JP) = XC(J,KM1)
      Y(2,JP) = YC(J,KM1)
      Z(2,JP) = ZC(J,KM1)
```

```
C   3RD CORNER
        X(3,JP) = XC(J,K)
        Y(3,JP) = YC(J,K)
        Z(3,JP) = ZC(J,K)
C   4TH CORNER
        X(4,JP) = XC(JM1,K)
        Y(4,JP) = YC(JM1,K)
        Z(4,JP) = ZC(JM1,K)
C   5TH CORNER  - CLOSE CURVE
        X(5,JP) = XC(JM1,KM1)
        Y(5,JP) = YC(JM1,KM1)
        Z(5,JP) = ZC(JM1,KM1)
        IF (JP.GE.300) GO TO 250
220     CONTINUE
230     CONTINUE
240     CONTINUE
C
C   PLOT PERSPECTIVE VIEWS OF PANEL GEOMETRY ---------------------------
250     CONTINUE
        IF (JP.LE.0) GO TO 999
C
C   TOP VIEW
        CALL PLOTV2(X,Y,IOPT,NPLT,NDP,JP,LWID,LENG,LINE,NLIN)
        WRITE(6,10)
C       CALL PLOTI (X,Y,IOPT,NPLT,NDP,JP,1,1,2HX*,2HY*)
C
C   SIDE VIEW
        CALL PLOTV2(X,Z,IOPT,NPLT,NDP,JP,LWID,LENG,LINE,NLIN)
        WRITE(6,11)
C       CALL PLOTI (X,Z,IOPT,NPLT,NDP,JP,1,1,2HX*,2HZ*)
C
C   FRONT VIEW
        CALL PLOTV2(Y,Z,IOPT,NPLT,NDP,JP,LWID,LENG,LINE,NLIN)
        WRITE(6,12)
C       CALL PLOTI (Y,Z,IOPT,NPLT,NDP,JP,1,1,2HY*,2HZ*)
C
C   PERSPECTIVE VIEW
        AROT(2) = 45.
        AROT(3) = -45.
        CALL PLOTA3(X,Y,Z,NPLT,NDP,JP,AROT,XCG,XP,YP,3)
        CALL PLOTV2(XP,YP,IOPT,NPLT,NDP,JP,LWID,LENG,LINE,NLIN)     Added
C       CALL PLOTI (XP,YP,IOPT,NPLT,NDP,JP,1,1,3HXP*,3HYP*)
        WRITE(6,13) AROT
        CALL CPUTIM(TIME,DT,1)
        WRITE(6,15) TIME,DT
10      FORMAT(/20X,20HTOP VIEW    = Y VS X )
11      FORMAT(/20X,20HSIDE VIEW   = Z VS X )
12      FORMAT(/20X,20HFRONT VIEW = Z VS Y )
13      FORMAT(/20X,19HPERSPECTIVE VIEW =
     *     ,7HTHETAX=,F8.3,5X,7HTHETAY=,F8.3,5X,7HTHETAZ=,F8.3)
15      FORMAT(/10X,18HEND PLOTG ,  TIME= ,F10.3,5X,3HDT=,F10.3)
C
999     RETURN
        END
```

```
      SUBROUTINE PLOTV2 (X,Y,IOPT,NP,NDP,NC,LWID,LENG,LINE,NLIN)
C+-----------------------------------------------------------------------
C
C     SUBROUTINE PLOTV2
C
```

```
C       PURPOSE
C          ROUTINE TO GENERATE A CHARACTER PLOT OF NC SIMULTANEOUS
C          CURVES OF  Y VS X.  A LINEAR INTERPOLATION IS MADE BETWEEN
C          SEQUENTIAL POINTS.
C
C
C       CALLING FORMAT
C          CALL PLOTV2 (X,Y,IOPT,NP,NOP,NC,LWID,LENG,LINE,NLIN)
C
C       PARAMETERS
C          NAME    TYPE   I/O/S   DIM    DESCRIPTION
C
C          X,Y       R       I (NOP,NC) ORDINATE + ABSCISSA ARRAYS
C          IOPT      I       I     NONE  OPTION FOR TYPE OF PAGE SCALING
C                                        1, USER SPECIFIES SCALE LIMITS
C                                        2, INTERNAL AUTOMATIC BEST SCALING
C                                        3, AUTOMATIC TRUE SHAPE SCALING, USES
C                                           RATIO: 0.6*LWID/LENG = XDIFF/YDIFF
C                                        4, USE MAX AND MIN VALUES OF DATA
C                                        5, INPUT XMAX,XMIN# AUTO Y-SCALING
C                                        6, INPUT YMAX,YMIN# AUTO X-SCALING
C          NP        I       I     NONE  VECTOR OF NUMBER OF POINTS IN J*TH
C                                        CURVE
C          NOP       I       I     NONE  FIRST DIMENSION OF ARRAYS *X,Y* IN
C                                        CALLING ROUTINE
C          NC        I       I     NONE  NUMBER OF SIMULTANEOUS PLOTS.
C                                        IF NC%41, CHARACTER SET REPEATS.
C          LWID      I       I     NONE  WIDTH OF PLOTTED REGIONS AT 10
C                                        CHARACTERS/INCH.  NORMALLY=100,
C                                        FOR CRT OR T.I. TERMINALS=50.
C                                        MAXIMUM DIMENSIONED = 100.
C          LENG      I       I     NONE  NUMBER OF LINES IN PLOTTED REGION
C                                        NORMALLY=50 AT 6 LINES/INCH#
C                                        FOR 8.5" PAPER=40.
C          LINE      I       S   (NLINE) SCRATCH MATRIX USED IN PLOTTING
C                                        CHARACTERS.  WHERE:
C                                        (LWID+3).LE.NLIN.LE.(LWID+3)(LENG+1)
C          NLIN      I       I     NONE  DIMENSIONED LENGTH OF SCRATCH ARRAY
C                                        *LINE*.  VALUES GREATER THAN (LWID+3)
C                                        ONLY IMPROVE THE EFFICIENCY OF THE
C                                        PLOT ALGORITHM
C
C
C       USER SUPPLIED COMMON BLOCKS
C          IOPT =1,5,6:  /BSCALE/ XMAX,XMIN,YMAX,YMIN
C
C       COMMON /BSCALE/
C          NAME    TYPE   I/O/S   DIM    DESCRIPTION
C
C          XMAX      R      I/O    NONE  MAXIMUM X SCALE VALUE ACROSS PAGE
C          XMIN      R      I/O    NONE  MINIMUM X SCALE VALUE ACROSS PAGE
C          YMAX      R      I/O    NONE  MAXIMUM Y SCALE VALUE AT TOP OF PAGE
C          YMIN      R      I/O    NONE  MINIMUM Y SCALE VALUE DOWN PAGE
C
C       EXTERNAL REFERENCES
C          PLOTA SUBROUTINES:  PLOTA7, PLOTA8
C
C       AUTHOR
C          JOSEPH MULLEN JR., NIELSEN ENGINEERING + RESEARCH, INC.
C          DATED: DECEMBER, 1975
C
C----------------------------------------------------------------------
      DIMENSION X(NOP,NC),Y(NOP,NC),XPRINT(7),NP(NC),FMT(6)
```

```
      INTEGER SYMBOL(40),LINE(NLIN)
      COMMON /BPLTAT/ NXPR,NYPR,IYAXIS,IXAXIS,IOFFX,IOFFY,LLINE
      COMMON /BSCALE/ XMAX,XMIN,YMAX,YMIN
C
      DATA FMT/4H(7X ,4H,G16,4H.4,6,4H( 4X,4HG16.,4H4)) /
      DATA SYMBOL/1H*,1H+,1H-,1H.,1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7
     *,1H8,1H9,1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK,1HL,1HM
     *,1HN,1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ/
C
C  FIND MAX AND MIN OF X (ORDINATE) AND Y (ABSCISSA)
C
      NPJ = 1
      IF (IOPT.LT.1) IOPT=2
C
      IF (IOPT.EQ.1) GO TO 80
      IF (IOPT.EQ.5) GO TO 60
      XMAX = X(1,1)
      XMIN = X(1,1)
      DO 50 J=1,NC
      NPJ = NP(J)
      IF (NPJ.LT.1) GO TO 50
      DO 40 I=1,NPJ
      XMAX = AMAX1(X(I,J),XMAX)
40    XMIN = AMIN1(X(I,J),XMIN)
50    CONTINUE
      IF (IOPT.EQ.6) GO TO 80
C
60    YMAX = Y(1,1)
      YMIN = Y(1,1)
      DO 70 J=1,NC
      NPJ = NP(J)
      IF (NPJ.LT.1) GO TO 70
      DO 65 I=1,NPJ
      YMAX = AMAX1(Y(I,J),YMAX)
65    YMIN = AMIN1(Y(I,J),YMIN)
70    CONTINUE
C
C  DETERMINE SCALING AND ROUND OFF MAX AND MIN VALUES AND LOCATE
C  X- AND Y-AXES.
C
80    CALL PLOTAR(DX,DY,FMT,LWID,LENG,IOPT)
      NROWS = LENG+1
      NDL = MAX0(NLIN/LLINE,1)
      IF (NDL.GT.NROWS) NDL=NROWS
C
C  INITIALIZE PLOTTING BANDWIDTH
C
      YLOW = YMAX+(0.5-NDL)*DY
      YMID = YMAX
      YUP  = YMAX+0.5*DY
C
C  FORM UPPER BOUNDARY
C
      CALL PLOTA7 (LINE,1,1)
      WRITE(6,1) (LINE(I),I=1,LLINE)
C
C  START LOOP ON COMPUTING ALL LINES THAT PASS THROUGH NEXT NDL LINES
C
      NBLK = NROWS/NDL
      IF (NBLK*NDL.LT.NROWS) NBLK=NBLK+1
      JSAVE = 0
      DO 160 IBLK=1,NBLK
C
```

```
C   INITIALIZE BLANK ROW OR X-AXIS
C
      J = JSAVE
      JK = 1
      DO 110 K=1,NOL
      J = J+1
      IF (J.GT.NROWS) GO TO 115
      IF (J.EQ.IXAXIS) CALL PLOTA7 (LINE(JK),J-IOFFX,1)
      IF (J.NE.IXAXIS) CALL PLOTA7 (LINE(JK),J-IOFFX,2)
      JK = JK+LLINE
110   CONTINUE
C
C   TEST FOR VECTOR DRAWN ACROSS NEXT NOL LINES OF OUTPUT
C
115   DO 140 L=1,NC
      LSYM = MOD(L-1,40)+1
      NPL = NP(L)
      IF (NPL.LT.1) GO TO 140
      X2 = X(1,L)
      Y2 = Y(1,L)
C
C   START LOOP ON NUMBER OF VECTORS IN EACH LINE
C
      DO 130 K=1,NPL
      X1 = X2
      Y1 = Y2
      X2 = X(K,L)
      Y2 = Y(K,L)
C
C   TEST WHETHER VECTOR CROSSES BLOCK OF LINES
C
      IF ((Y1.GE.YUP).AND.(Y2.GE.YUP)) GO TO 130
      IF ((Y1.LT.YLOW).AND.(Y2.LT.YLOW)) GO TO 130
C
C   COMPUTE INTERMEDIATE POINTS AND STORE IN LINE.
C
      DELX = X2-X1
      DELY = Y2-Y1
      IDX = IFIX(ABS(DELX/DX))
      IDY = IFIX(ABS(DELY/DY))
      NV = MAX0(IDX,IDY)+1
      DELX = DELX/NV
      DELY = DELY/NV
      NV = NV+1
      XV = X1
      YV = Y1
C
      DO 125 IV=1,NV
      IX = IFIX((XV-XMIN)/DX+0.5)+2
      IY = IFIX((YUP-YV)/DY+1.)
      IF ((IY.LT.1).OR.(IY.GT.NOL))   GO TO 120
      IF ((IX.LT.2).OR.(IX.GE.LLINE)) GO TO 120
      IXY = LLINE*(IY-1)+IX
      LINE(IXY) = SYMBOL(LSYM)
120   XV = XV+DELX
      YV = YV+DELY
125   CONTINUE
130   CONTINUE
140   CONTINUE
C
C   PRINT NOL LINES OF OUTPUT - CHECK FOR SCALES
C
      J = JSAVE
```

```
      JK = 1
      JK2 = LLINE
      DO 150 K=1,NCOL
      J = J+1
      IF (J.GT.NROWS) GO TO 160
      IMOD = MOD(J-IOFFX-1,NYPR)
      IF (IMOD.EQ.0) WRITE (6,2) YMID,(LINE(I),I=JK,JK2)
      IF (IMOD.NE.0) WRITE (6,3) (LINE(I),I=JK,JK2)
      JK = JK+LLINE
      JK2 = JK2+LLINE
C
C  INCREMENT Y-STRIP; REDEFINE YLOW AND YUP
C
      YUP = YUP-DY
      YMID = YMID-DY
      IF (ABS(YMID/DY).LT.0.001) YMID=0.0
      YLOW = YLOW-DY
150   CONTINUE
      JSAVE = J
160   CONTINUE
C
C  FORM LOWER BOUNDARY
C
      CALL PLOTA7 (LINE,1,1)
      WRITE (6,3) (LINE(I),I=1,LLINE)
C
C  PRINT SCALES
C
      NXP = (LLINE-IOFFY)/NXPR+1
      XPRINT(1) = XMIN+DX*(IOFFY-2)
      DO 240 I=2,NXP
      XPRINT(I) = XPRINT(I-1)+DX*NXPR
      IF (ABS(XPRINT(I)/DX).LT.0.001) XPRINT(I)=0.0
240   CONTINUE
      WRITE(6,FMT) (XPRINT(I),I=1,NXP)
      RETURN
1     FORMAT (1H1,14X,103A1)
2     FORMAT (1X,G13.4,1X,103A1)
3     FORMAT (15X,103A1)
      END
```

```
      SUBROUTINE PRESS(NP,XMACH,ARA,U,V,W,CPP,CPSTAG,CPCRIT,CPVAC,COMPT)
C
C  THE PRESSURE COEFFICIENT IS CALCULATED USING THE EXACT ISENTROPIC
C  FORMULA IN ALL CASES EXCEPT FOR WING, CANARD (HORIZONTAL TAIL),
C  AND FIN (VERTICAL TAIL) COMPONENTS ANALYZED UNDER THE PLANAR
C  BOUNDARY CONDITION OPTION. IN THESE CASES, THE LINEARIZED THEORY
C  PRESSURE COEFFICIENT FORMULA IS USED AND THE PRESSURE COEFFICIENT
C  IS LIMITED BY THE VACUUM PRESSURE COEFFICIENT.
C
C  COMPUTE THE STAGNATION PRESSURE COEFFICIENT, CRITICAL PRESSURE
C  COEFFICIENT, AND VACUUM PRESSURE COEFFICIENT.
C
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,AMACH,ALPHA,BETA,ALPHAC
     1 ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      DIMENSION U(1),V(1),W(1),CPP(1)
      INTEGER COMPT
      LOGICAL LBC
```

```
      XM2=XMACH*XMACH
      CPCRIT=0.
      CPSTAG=1.
      CPVAC=0.
      COSARA=COS(ARA)
      SINARA=SIN(ARA)
      IF (XM2.EQ.0.) GO TO 10
      CON=1.42857/XM2
      CPVAC=-CON
      CON1=.2*XM2
C
C  LOOP THROUGH NP-PANELS TO CALCUALTE PRESSURE COEFFICIENTS  ----------
C
10    DO 40 J=1,NP
      UWPM=U(J)*COSARA+W(J)*SINARA
      IF (LBC.AND.COMPT.EQ.2) GO TO 20
      UWIND=1.+UWPM
      VWIND=V(J)
      WWIND=W(J)*COSARA-U(J)*SINARA
      VW2=VWIND*VWIND+WWIND*WWIND
      Q2=UWIND*UWIND+VW2
      IF (XMACH.EQ.0.) GO TO 30
      ARG=1.+CON1*(1.-Q2)
      IF (ARG.LT.0.) ARG=0.
      CPP(J)=CON*(ARG**3.5-1.)
      GO TO 40
20    CPP(J)=-2.*U(J)
C
C  CONSTRAIN THE PRESSURE COEFFICIENT SO THAT IT DOES NOT
C  EXCEED THE VACUUM PRESSURE COEFFICIENT
C
      IF (CPP(J).LT.CPVAC) CPP(J)=CPVAC
      GO TO 40
30    CPP(J)=1.-Q2
40    CONTINUE
      IF (XMACH.EQ.0.) RETURN
      CPSTAG=CON*((1.+CON1)**3.5-1.)
      CPCRIT=CON*((5./6.+XM2/6.)**3.5-1.)
      RETURN
      END
```

```
      SUBROUTINE PRTCPT(NBODY)
C
C  ROUTINE TO PRINT A COPY OF THE CONTROL POINTS AFT OF *XSTART*
C  AND FORWARD OF *XWLE* ON TAPE4 FOR USE BY OTHER PROGRAMS
C
      COMMON /JOPTNS/ IZ1(59),NVLIN
     *   ,NCPOUT,XSTART,XWLE,NWCPT,IPLOT(4),IPRT(5),IXZSYM
      COMMON /POINT / XPT(600),YPT(600),ZPT(600),THET(600),DELTA(600),
     1   XC(30,20),YC(30,20),ZC(30,20),DELTI(600),XLE(600)
C
      IF (NWCPT.NE.0) GO TO 999
      IF (NVLIN.GT.0) GO TO 999
      WRITE(6,750)
      REWIND 4
      IJ = 0
      DO 100 I=1,NBODY
      IF (XPT(I).LT.XSTART) GO TO 100
```

```
      IF (XPT(I).GT.XHLE) GO TO 100
      IJ = IJ+1
      WRITE(4,745) IJ,XPT(I),YPT(I),ZPT(I)
      WRITE(6,745) IJ,XPT(I),YPT(I),ZPT(I)
100   CONTINUE
      ENDFILE 4
      IF (NCPOUT.EQ.2) STOP 500
999   RETURN
C
750   FORMAT(1H1,9X,42HSUMMARY OF CONTROL POINTS WRITTEN ON TAPE4
     *   ,58X,12H** PRTCPT **)
745   FORMAT(I5,3G12.5)
      END
```

```
      SUBROUTINE READVX (NFUS,NFORX,LPRT)
C
C  ROUTINE TO READ THE VORTEX LOCATIONS AND STRENGTHS OF BODY VORTICES
C
      DIMENSION XFUS(30,4),FUSBY(30,4),FUSAZ(30,4),NFORX(4)
      LOGICAL LPRT
C
      COMMON /BVRTX / NVTX,NXVTX,XV(10),AV(10),BV(10)
      COMMON          BLOCK(7500)
C
      EQUIVALENCE (XFUS(1,1),BLOCK(1))
     *   ,(FUSBY(1,1),BLOCK(361))      ,(FUSAZ(1,1),BLOCK(481))
C
      IF (NXVTX.LE.0) GO TO 999
C
C  READ VORTEX PATH X-STATIONS
      READ (5,160) (XV(I),I=1,NXVTX)
      IF (LPRT) WRITE(6,170) (XV(I),I=1,NXVTX)
C
C  INTERPOLATE IN GEOMETRY FOR MAJOR AND MINOR AXES,
C  B AND A RESPECTIVELY.
C
      DO 120 K=1,NXVTX
C        FIND GEOMETRY BODY STATION
      DO 100 NFU=1,NFUS
      NFUSOR=NFORX(NFU)
      DO 100 J=2,NFUSOR
      IF (XV(K).LE.XFUS(J,NFU)) GO TO 110
100   CONTINUE
      J = NFUSOR
      NFU = NFUS
110   JM1 = J-1
      DX = XFUS(J,NFU)-XFUS(JM1,NFU)
      IF (DX.NE.0.) DX=(XV(K)-XFUS(JM1,NFU))/DX
C
C        INTERPOLATE FOR A AND B
C
      AV(K) = FUSAZ(JM1,NFU)+DX*(FUSAZ(J,NFU)-FUSAZ(JM1,NFU))
      BV(K) = FUSBY(JM1,NFU)+DX*(FUSBY(J,NFU)-FUSBY(JM1,NFU))
120   CONTINUE
      IF (LPRT) WRITE(6,180) (BV(I),I=1,NXVTX)
      IF (LPRT) WRITE(6,190) (AV(I),I=1,NXVTX)
999   RETURN
C
```

```
160   FORMAT(10F7.0)
170   FORMAT(///,10X,30HVORTEX LOCATIONS AND BODY AXES,
     *   70X,12H** REAUVX ** ,//5H  XV=,10F10.4)
180   FORMAT(/5H  BY=,10F10.4)
190   FORMAT(/5H  AZ=,10F10.4)
      END
```

```
      SUBROUTINE RDVEL(VA,WA,XPT,YPT,ZPT,NBODY,XSTART,XMLE)
C
C  ROUTINE TO READ VELOCITY COMPONENTS AT CONTROL POINTS DEFINED IN
C  PRTCPT.
C
      DIMENSION VA(1),WA(1),XPT(1),YPT(1),ZPT(1)
      REWIND 4
C
      WRITE(6,750)
      DO 100 I=1,NBODY
      IF (XPT(I).LT.XSTART) GO TO 100
      IF (XPT(I).GT.XMLE) GO TO 100
      READ(4,745) IJ,XCP,YCP,ZCP,VA(I),WA(I)
      IF (EOF(4).NE.0.) GO TO 100
      WRITE(6,745) I,XPT(I),YPT(I),ZPT(I),VA(I),WA(I)
100   CONTINUE
      RETURN
C
745   FORMAT(I5,5G12.5)
750   FORMAT(1H1,9X,34HVORTEX VELOCITIES READ FROM TAPE4 ,
     *   56X,12H** RDVEL  **,
     *  //4X,1HI,3X,3HXPT,9X,3HYPT,9X,3HZPT,10X,2HVA,10X,2HWA/)
      END
```

```
      SUBROUTINE SCAMP4(X,Y,N,NDA,NDB,DA,DB,C,S,M)
C
C   GIVEN A SET OF N POINTS WHOSE ABSCISSAE FORM A STRICTLY MONOTONIC
C   SEQUENCE, AND GIVEN A FIRST OR SECOND DERIVATIVE AT X(1) AND A
C   FIRST OR SECOND DERIVATIVE AT X(N), TO FIND THE SMOOTHEST POSSIBLE
C   CURVE PASSING RIGUROUSLY THROUGH THE GIVEN POINTS, SATISFYING THE
C   SPECIFIED BOUNDARY CONDITIONS, AND POSSESSING CONTINUOUS FIRST AND
C   SECOND DERIVATIVES. THE CRITERION OF SMOOTHNESS IS THE
C   MINIMIZATION OF THE INTEGRAL OF THE SQUARE OF THE SECOND
C   DERIVATIVE, AND THE CUBIC FOUND IS ACCORDINGLY A CHAIN OF CUBICS,
C   I. E., A SEPARATE CUBIC ON EACH INTERVAL (X(I),X(I+1))
C
      DIMENSION C(4,1),S(1),X(1),Y(1),Z(4)
      L=1
      KK=1
      D1=DA
      D2=DB
      IF (M.NE.12) GO TO 10
      KK=2
10    IF ((NDA+1).LT.0) D1=DERIV2(X,Y,X)
      IF ((NDA+1).EQ.0) D1=DERIV1(X,Y,1)
      NA=IABS(NDA)
60    IF (( DB+1).LT.0) D2=DERIV2(X(N-3),Y(N-3),X(N))
      IF ((NDB+1).EQ.0) D2=DERIV1(X(N-2),Y(N-2),3)
```

```
      NN=IABS(NOB)
      CALL COMCU(D1,D2,S,X,Y,M,N,NA,NB)
      IF (M.NE.0) RETURN
      K=N-1
      DO 50 J=1,K
      CALL CUBIC2(X(J),Y(J),S(J),Z,M)
      IF (M.EQ.1) GO TO 20
      M=100*J+M
      RETURN
20    IF (KK.EQ.2) GO TO 40
      DO 30 I=1,4
      C(I,J)=Z(I)
30    CONTINUE
      GO TO 50
40    L=7*J
      C(L-6,1)=X(J)
      C(L-5,1)=X(J+1)
      C(L-4,1)=3.
      C(L-3,1)=Z(1)
      C(L-2,1)=Z(2)
      C(L-1,1)=Z(3)
      C(L,1)=Z(4)
50    CONTINUE
      M=0
      RETURN
      END


      SUBROUTINE SOLVE
CDC   OVERLAY (LWB,3,0)
CDC   PROGRAM SOLVE
C
C  SOLVE FOR THE STRENGTHS OF THE BODY SOURCES AND WING VORTICES
C  WHICH SATISFY THE BOUNDARY CONDITION OF TANGENTIAL FLOW AT THE
C  PANEL CONTROL POINTS. ALSO DETERMINE THE CORRESPONDING PRESSURE
C  DISTRIBUTION AND THE FORCES AND MOMENTS ON THE CONFIGURATION.
C
C  THE PROGRAM MUST SOLVE A SYSTEM OF LINEAR EQUATIONS OF MAXIMUM
C  ORDER 1200. THE SOLUTION TECHNIQUE SELECTED CAN BE DESCRIBED AS A
C  BLOCKED JACOBI ITERATIVE METHOD. THE 1200 BY 1200 MATRIX IS
C  NATURALLY PARTITIONED INTO FOUR 600 BY 600 BLOCKS. EACH PARTITION
C  IS FURTHER SUBDIVIDED INTO BLOCKS OF MAXIMUM SIZE 60 BY 60. THE
C  MATRIX ELEMENTS IN EACH BLOCK ARE CAREFULLY CHOSEN TO REPRESENT
C  SOME WELL DEFINED FEATURE OF THE ORIGINAL CONFIGURATION. FOR
C  EXAMPLE, A BODY BLOCK REPRESENTS THE INFLUENCE OF ONE RING OF
C  PANELS AROUND THE BODY, WHILE A WING BLOCK REPRESENTS THE
C  INFLUENCE OF ONE CHORDWISE COLUMN OF WING PANELS. FOR WINGS USING
C  THE NON-PLANAR BOUNDARY CONDITION OPTION, THE BLOCK SIZE
C  CORRESPONDS TO THE TOTAL NUMBER OF PANELS ON THE UPPER AND LOWER
C  SURFACES OF THE COLUMN.  THIS ENSURES DOMINANCE OF THE ELEMENTS
C  ALONG THE DIAGONAL
C
C  THE INITIAL ITERATION CALCULATES THE SINGULARITY STRENGTHS
C  CORRESPONDING TO EACH BLOCK IN ISOLATION. FOR THIS STEP, ONLY THE
C  DIAGONAL BLOCKS ARE PRESENT IN THE AERODYNAMIC MATRIX.  ONCE THE
C  INITIAL APPROXIMATION TO THE SINGULARITY STRENGTHS IS DETERMINED,
C  THE INTERFERENCE EFFECT OF EACH BLOCK ON ALL THE OTHERS IS
C  CALCULATED BY MATRIX MULTIPLICATION.  THE INCREMENTAL NORMAL
C  VELOCITIES OBTAINED ARE SUBTRACTED FROM THE NORMAL VELOCITIES
C  SPECIFIED BY THE BOUNDARY CONDITIONS.  THIS PROCESS IS ITERATED
```

```
C   UNTIL A CONVERGENCE TEST ON THE MAXIMUM RESIDUAL IS SATISFIED OR A
C   MAXIMUM NUMBER OF ITERATIONS IS REACHED.
C   ------------------------------------------------------------------
C   BODY ONLY VERSION:                                     JUNE 1977
C   THOSE PORTIONS OF THE ORIGINAL PROGRAM *UNAERO* WHICH PERTAINED
C   TO CALCULATIONS OF WINGS HAVE BEEN DELETED.
C                                                     JOE MULLEN
C   ------------------------------------------------------------------
C
C   TAPE USAGE IN SOLVE-
C     TAPE7:  SOLVE,    READ  ARRAY      - CALCULATE BOUNDARY CONDITION
C             DIAGIN,   READ  D          - INVERT DIAGONALS,  N GT NMAX
C             SOLVE,    REWIND
C                       READ  ARRAY      - CALCULATE NORMAL VELOCITIES
C                       REWIND
C
C     TAPE8:  SOLVE,    REWIND
C                       READ  UA,VA,WA   - CALCULATE U,V,W
C                       REWIND
C
C     TAPE9:  PARTIN,   REWIND
C                       READ  D        - INVERT DIAGONAL BLOCKS, N LT NMAX
C                       REWIND
C             DIAGIN,   REWIND
C                       READ  D        - INVERT DIAGONAL BLOCKS, N LT NMAX
C             ITRATE,   REWIND
C                       READ  A        - ITERATE WITH AIC FOR SOLN
C
C     TAPE10: PARTIN,   REWIND
C                       WRITE  D(INVERSE)
C                       REWIND
C             DIAGIN,   REWIND
C                       WRITE  D(INVERSE) - DIAGONAL BLOCKS
C                       REWIND
C             ITRATE,   REWIND
C                       READ   D(INVERSE) - ITERATE ON SOLUTION
C
      COMMON /JOPTNS/ IZ1(59),NVLIN
     * ,NCPOUT,XSTART,XWLE,NWCPT,IPLOT(4),IPRT(5),IXZSYM
      COMMON           U(600),V(600),W(600),A(60,60),Z3(300),GW(600),
     1  GB(600),DZTDX(600)
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1  ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,IPRINT,NWTHK
     1  ,NWBLOK,NWROW(20),NBBLOK,NBROW(60)
      COMMON /POINT / ARRAY(6000)
      COMMON /MATCOM/ MATIN
C
      DIMENSION UA(600),VA(600),WA(600),CP(600),NS(600),CHORD(600)
     1  ,THET(600),DELTA(600),NB(600),NW(600),NT(600),DEL(600)
     2  ,COSTH(600),XPT(600),YPT(600),ZPT(600)
C
      EQUIVALENCE                      (U(1),NW(1))
     1  ,(V(1),NB(1)),                 (W(1),NT(1))
     2  ,(UA(1),A(1,1)),               (VA(1),A(1,11))
     3  ,(WA(1),A(1,21)),              (CP(1),A(1,31))
     4  ,(NS(1),A(1,41)),              (GW(1),DEL(1))
     5  ,(GB(1),COSTH(1))
     6  ,(XPT(1),ARRAY(1)),            (YPT(1),ARRAY(601))
     7  ,(ZPT(1),ARRAY(1201)),         (THET(1),ARRAY(1801))
     8  ,(DELTA(1),ARRAY(2401)),       (CHORD(1),ARRAY(3601))
      REAL NB,NW,NT,NS
      INTEGER COMPT
```

```
      LOGICAL LBC,THK
      DATA RADDEG/0.0174532926/
C
      CALL CPUTIM(TIME0,DT,1)
      EM=XMACH
      NPASS=0
      REWIND 7
      REWIND 8
      ALP=ALPHA*RADDEG
      ALPHAC=ALPHA
      PHI=PHIR*RADDEG
      SINAL=SIN(ALP)
      COSAL=COS(ALP)
      SINB=0.
      SINA=SINAL
C
C
C     ALPHAC.......INCLUDED ANGLE OF ATTACK
C     PHI..........ANGLE OF ROLL
C     ALPHA........ANGLE OF PITCH
C     BETA.........ANGLE OF SIDE SLIP
C     ALL IN DEGREES.
C
C
      IF (IYZSYM.EQ.0) GO TO 5
      SINB=SINAL*SIN(PHI)
      SINA=SINAL*COS(PHI)
      BETA=ASIN(SINB)/RADDEG
      ALPHA=ASIN(SINA)/RADDEG
      IF (IPRINT.NE.0) WRITE(6,430) ALPHAC,PHIR,ALPHA,BETA
5     CONTINUE
C
C  CALCULATE NORMAL VELOCITIES REQUIRED TO SATISFY BOUNDARY
C  CONDITIONS AT BODY CONTROL POINTS
C
20    IF (NBODY.EQ.0) GO TO 70
C
C  BOUNDARY CONDITION FOR BODY.CONTRIBUTION FROM FREE STREAM.
C
      READ (7) ARRAY
      DO 30 I=1,NBODY
      VN(I)=COSAL*SIN(DELTA(I))
     1   +COS(DELTA(I))*(-SINA*COS(THET(I))-SINB*SIN(THET(I)))
30    CONTINUE
C
C ----------------------------------------------------------------
C  SOLVE MATRIX EQUATIONS - DIRECT SOLUTION IF MATRIX LESS THAN 60X60,
C   OTHERWISE ITERATIVE SOLUTION
C
70    IF (NBODY.LE.NMAX.AND.NWING.LE.NMAX) GO TO 80
      IF (MATIN.EQ.1) CALL DIAGIN
      REWIND 10
      GO TO 90
80    CALL PARTIN
      IF (NBODY.EQ.0.OR.NWING.EQ.0) GO TO 100
90    CALL ITRATE
100   REWIND 7
110   NPASS=NPASS+1
      IF (NBODY.EQ.0) GO TO 220
C
C  CALCULATE VELOCITY COMPONENTS ON BODY PANELS  ----------------------
C            U = UA*GB,  V = VA*GB,  W = WA*GB
C
```

```
      DO 140 I=1,NBODY
      U(I)=0.
      V(I)=0.
      W(I) = 0.
      READ (8) (UA(J),VA(J),WA(J),J=1,NBODY)
      DO 130 J=1,NBODY
      U(I)=U(I)+UA(J)*GB(J)
      V(I)=V(I)+VA(J)*GB(J)
      W(I)=W(I)+WA(J)*GB(J)
130   CONTINUE
140   CONTINUE
C
C  CALCULATE WING VELOCITY COMPONENTS HERE DUE TO VORTEX SHEDDING ------
C  FROM NOSE:              V = V+V(VOR),    W = W+W(VOR)
C
      IF (NPASS.EQ.1) READ (7) ARRAY
      DO 145 I=1,NBODY
      VA(I)=0.
145   WA(I)=0.
C
C  COMPUTE VORTEX VELOCITIES BY INTERPOLATION IN STRENGTHS USING VVELS
C
      CALL ELBOVT (VA,WA,XPT,YPT,ZPT,NBODY)
C
C  READ IN VELOCITY CONTRIBUTIONS FOR CONTROL POINTS WRITTEN OUT BY
C  PRTCPT.  VELOCITY COMPONENTS ARE COMPUTED BY VPATHL
C
      IF (NVLIN.EQ.1 .AND. NCPOUT.LE.0)
     *   CALL RDVEL(VA,WA,XPT,YPT,ZPT,NBODY,XSTART,XWLE)
C
C  COMPUTE NORMAL VELOCITIES AT CONTROL POINTS
C
      DO 190 I=1,NBODY
180   NS(I)=(W(I)*COS(THET(I))-V(I)*SIN(THET(I)))*COS(DELTA(I))-U(I)*
     1 SIN(DELTA(I))
190   CONTINUE
      IF (IABS(IPRINT).LT.2) GO TO 210
      WRITE (6,350) EM,ALPHAC,PHIR
      WRITE (6,400)
      DO 200 N=1,NBODY
      WRITE (6,420) N,GB(N),U(N),V(N),W(N),NS(N),VA(N),WA(N)
200   CONTINUE
C
C  CALCULATE PRESSURES ON BODY PANELS, THEN
C  CALCULATE FORCES AND MOMENT ON BODY
C
210   COMPT=1
      DO 150 I=1,NBODY
      V(I) = V(I)+VA(I)
150   W(I) = W(I)+WA(I)
      CALL PRESS(NBODY,EM,ALP,U,V,W,CP,CPSTAG,CPCRIT,CPVAC,COMPT)
      CALL FORMOM(NBODY,NPASS,ALP,COMPT,.FALSE.)
C
C  COMPUTE FORCE AND MOMENTS FOR CONTROL POINTS BETWEEN XSTART AND XWLE
C
      CALL FORMOM(NBODY,NPASS,ALP,COMPT,.TRUE.)
220   CONTINUE
340   WRITE (6,390) CPSTAG,CPCRIT,CPVAC
      REWIND 7
C     REWIND 8
      CALL CPUTIM(TIME,DT,1)
      DT=TIME-TIME0
      WRITE(6,440) TIME,DT
```

```
      RETURN
  350 FORMAT (///10X,16HVELOCITY ON BODY,84X,12H** SOLVE  **,
     *  //5X,5HMACH=,F6.3,3X,6HALPHA=,F7.3,3X,5HPHIR=,F7.3//)
  390 FORMAT (/9H CPSTAG =,F10.5,3X,8HCPCRIT =,F10.5,3X,7HCPVAC =,F10.5)
  400 FORMAT (8X,5HPANEL,3X,6HSOURCE, 7X,5HAXIAL,10X,7HLATERAL,10X,
     1   8HVERTICAL,10X,6HNORMAL,8X,10HLAT.VORTEX,7X,10HVER.VORTEX
     2   ,/8X,3HNO.,4X,8HSTRENGTH,4X,8HVELOCITY,5(9X,8HVELOCITY))
  420 FORMAT (I12,F10.5,G15.5,5G17.5)
  430 FORMAT(//10X,25HCOMBINED ANGLES OF ATTACK,75X,12H** SOLVE **
     *   ,/5X,7HALPHAC=,F10.4,5X,7H  PHIR=,F10.4
     *   ,/5X,7H ALPHA=,F10.4,5X,7H  BETA=,F10.4)
  440 FORMAT(/5X,18HEND SOLVE,    TIME=,F10.4,5X,3HDT=,F10.4)
      END
```

```
      SUBROUTINE SORPAN(UPM,VPM,WPM)
C
C  COMPUTE THE THREE COMPONENTS OF VELOCITY INDUCED AT A SPECIFIED
C  CONTROL POINT BY A CONSTANT SOURCE DISTRIBUTION ON A
C  QUADRILATERAL PANEL HAVING LONGITUDINAL TAPER AND INCLINED AT AN
C  ANGLE DELTA TO THE FREE STREAM DIRECTION
C
      COMMON /BODCOM/ AMACH,SA,CX,XC(4),YC(4),ZC(4),XI,YI,ZI,XJ,ZJ
      DIMENSION SX(4),SM(4),DX(4),DY(4),DZ(4),D(4),E(4),F(4),G(4),
     1 H(4),XPM(4),YMX(4),ZAX(4),AYM(4),RPM2(4)
C
      REAL NUM
      DATA EPS,PI/1.E-5,3.14159265/
C
      EP2=EPS*EPS
      BT2=1.-AMACH*AMACH
      BTA=SQRT(ABS(BT2))
      BA2=BT2*SA*SA
      TA=1.+BA2
      IF (TA.LT.0.) GO TO 200
      SM(3)=0.
      DO 190 I=1,4
      ZC(I)=ZJ-SA*(XJ-XC(I))
      IF (I.LE.2) SM(1)=(YC(2)-YC(1))/CX
      IF (I.GT.2) SM(3)=(YC(4)-YC(3))/CX
      SM(2)=SM(1)
      SM(4)=SM(3)
      SSM=SIGN(1.,SM(I))
      BM2=BT2*SM(I)*SM(I)
      TAM=TA+BM2
      IF (ABS(TAM).LE.EPS) TAM=0.
      SAM=SQRT(ABS(TAM))
      SAMD=1./SAM
      CPM=CX*SAM
      DX(I)=XI-XC(I)
      DY(I)=YI-YC(I)
      DZ(I)=ZI-ZC(I)
      IF (ABS(DX(I)).LE.EPS) DX(I)=0.
      IF (ABS(DY(I)).LE.EPS) DY(I)=0.
      IF (ABS(DZ(I)).LE.EPS) DZ(I)=0.
      RPM2(I)=0.
      DX2=DX(I)*DX(I)
      DY2=DY(I)*DY(I)
      DZ2=DZ(I)*DZ(I)
      DR2=DY2+DZ2
```

```
      D2=DX2+BT2*DR2
      D(I)=0.
      IF (AMACH.GE.1.) DXZ=DX(I)-BTA*ABS(DZ(I))
      IF (AMACH.GE.1..AND.DXZ.LT.0.) GO TO 170
      IF (D2.GT.0.) D(I)=SQRT(D2)
      XPM(I)=DX(I)+BT2*(SM(I)*DY(I)+SA*DZ(I))
      YMX(I)=DY(I)-SM(I)*DX(I)
      ZAX(I)=DZ(I)-SA*DX(I)
      AYM(I)=SA*DY(I)-SM(I)*DZ(I)
      IF (ABS(XPM(I)).LE.EPS) XPM(I)=0.
      IF (ABS(YMX(I)).LE.EPS) YMX(I)=0.
      IF (ABS(ZAX(I)).LE.EPS) ZAX(I)=0.
      IF (ABS(AYM(I)).LE.EPS) AYM(I)=0.
      IF (I.LE.2) RPM2(1)=YMX(1)**2+ZAX(1)**2+BT2*AYM(1)**2
      RPM2(2)=RPM2(1)
      IF (I.GT.2) RPM2(3)=YMX(3)**2+ZAX(3)**2+BT2*AYM(3)**2
      RPM2(4)=RPM2(3)
      IF (ABS(RPM2(I)).LE.EP2) RPM2(I)=0.
      RPM=SQRT(ABS(RPM2(I)))
      IF (RPM.LE.EPS) RPM=0.
      DPM=SAM*D(I)
      F(I)=0.
      DNOM=-DX(I)*YMX(I)-BT2*DZ(I)*AYM(I)
      FNUM=D(I)*ZAX(I)
      IF (FNUM.EQ.0..AND.DNOM.EQ.0.) GO TO 10
      IF (D(I).EQ.0..OR.ZAX(I).EQ.0.) FNUM=0.
      F(I)=ATAN2(FNUM,DNOM)
      IF (D(I).EQ.0.) F(I)=F(I)*SIGN(1.,ZAX(I))
10    IF (TAM) 100,90,20
20    IF (AMACH.GT.1..AND.D(I).EQ.0.) GO TO 70
      IF (RPM.LE.EPS) GO TO 40
      NUM=XPM(I)+DPM
      G(I)=ALOG(NUM/(BTA*RPM))*SAMD
      GO TO 160
40    SX(I)=SIGN(1.,XPM(I))
      IF (AMACH.LT.1.) GO TO 50
      IF (I.EQ.1.AND.XPM(1).LT.CPM) GO TO 130
      IF (I.EQ.3.AND.XPM(3).LT.CPM) GO TO 140
50    IF (I.EQ.2) SGN12=SX(1)*SX(2)
      IF (I.EQ.4) SGN34=SX(3)*SX(4)
      IF (XPM(I)) 60,70,80
60    IF (I.EQ.2.AND.SGN12.LT.0.) GO TO 130
      IF (I.EQ.4.AND.SGN34.LT.0.) GO TO 140
      G(I)=-ALOG(ABS(XPM(I)))*SAMD
      GO TO 160
70    G(I)=0.
      GO TO 160
80    G(I)=ALOG(XPM(I))*SAMD
      GO TO 160
90    G(I)=0.
      IF (XPM(I).GT.BTA*RPM) G(I)=D(I)/XPM(I)
      GO TO 160
100   G(I)=0.
      ARG=SIGN(1.,XPM(I))
      IF (RPM.NE.0.) ARG=XPM(I)/(BTA*RPM)
      IF (ARG.GE.1.) GO TO 160
      IF (ARG.LE.-1.) GO TO 110
      IF (D(I).GT.0.) G(I)=ACOS(ARG)*SAMD
      GO TO 160
110   AM2=SA*SA+SM(I)*SM(I)
      TRM1=(SM(I)*DY(I)+SA*DZ(I)+ABS(AYM(I))*SAM)/AM2
      IF (DX(I).GT.TRM1) GO TO 120
      F(I)=0.
```

```
      IF (SSM.GT.0.) F(I)=PI*SIGN(1.,ZAX(I))
      GO TO 160
120   IF (SSM*YMX(I).GE.0.) GO TO 160
      G(I)=PI*SAMD
      GO TO 160
130   G(1)=500.*SAMD
      IF (AMACH.LT.1.) G(2)=-G(1)
      GO TO 160
140   G(3)=500.*SAMD
      IF (AMACH.LT.1.) G(4)=-G(3)
160   H(I)=0.
      HARG=-BTA*DY(I)
      IF (D(I).EQ.0..AND.HARG.EQ.0.) GO TO 180
      IF (AMACH.LT.1.) H(I)=BTA*.5*ALOG((D(I)+HARG)/(D(I)-HARG))
      IF (AMACH.GT.1.) H(I)=BTA*ATAN2(D(I),HARG)
      GO TO 180
170   F(I)=0.
      G(I)=0.
      H(I)=0.
      AYM(I)=0.
      YMX(I)=0.
      ZAX(I)=0.
      XPM(I)=0.
      DPM=0.
      RPM=0.
      RPM2(2)=RPM2(1)
      RPM2(4)=RPM2(3)
180   E(I)=H(I)+BT2*SM(I)*G(I)
190   CONTINUE
      TAD=1./TA
      E14=(E(1)-E(2)-E(3)+E(4))*TAD
      F14=(F(1)-F(2)-F(3)+F(4))*TAD
      G14=G(1)-G(2)-G(3)+G(4)
      R4PI=1./(4.*PI)
      IF (AMACH.GT.1.) R4PI=2.*R4PI
      UPM=R4PI*(E14/BT2-SA*F14)
      VPM=-R4PI*G14
      WPM=R4PI*(F14+SA*E14)
      RETURN
200   WRITE (6,210)
      STOP
210   FORMAT (1H0,43HERROR - BODY PANEL SLOPE EXCEEDS MACH ANGLE)
      END
```

```
      SUBROUTINE VELCMP
CDC   OVERLAY (LWB,2,0)
CDC   PROGRAM VELCMP
C
C  COMPUTE THE VELOCITY COMPONENTS (U,V,W) AT THE PANEL CONTROL
C  POINTS AND FORM THE AERODYNAMIC INFLUENCE COEFFICIENT MATRICES
C
C  TAPE USAGE IN VELCMP-
C    TAPE5:  READ XMACH,ALPHA,PHIR
C
C    TAPE7:  VELCMP,  REWIND
C                     READ ARRAY    - CALCULATE BODY INDUCED VELOCITIES
C                     WRITE D       - DIAGONAL BLOCKS, N GT NMAX
C                     REWIND
```

```
C     TAPE8:  VELCMP,   REWIND
C             BODVEL,   WRITE  UB,VB,WB - COMPONENT VELOCITY MATRICES
C             VELCMP,   REWIND
C
C     TAPE9:  VELCMP,   REWIND
C             BODVEL,   WRITE  AN      - NORMAL VELOCITY MATRIX
C             VELCMP,   REWIND
C
C     TAPE10: VELCMP,   REWIND
C             BODVEL,   WRITE  DN      - DIAGONAL BLOCKS, N GT NMAX
C             VELCMP,   REWIND
C                       READ  D        - COPY TO TAPE7
C                       REWIND
C
C     TAPE11:  NOT USED BY BODY VERSION
C
      COMMON /JOPTNS/ IZ1(63),NACPT,IPLOT(4),IPRT(5),IXZSYM
      COMMON /PARAM / NBODY,NWING,NTAIL,LBC,THK,XMACH,ALPHA,BETA,ALPHAC
     1   ,PHIR,REFA,REFB,REFC,REFD,REFL,REFX,REFZ
      COMMON /VELCOM/ NPOINT,NPART,IMAX,JMAX,NMAX,EM,IPRINT,NWTHK
     1   ,NWBLOK,NWROW(20),NBBLOK,NBROW(30)
      COMMON /NEWCOM/K1,KWAF,KWAFOR,KRADX(4),KFORX(4),KFUS,MAX,K4,K5
     1   ,KF(6),KAN(6),KFINOR(6),KANOR(6),KOL,NCPT,LOCPT(20),XCPT(20)
      COMMON          BLOCK(7500)
      COMMON /POINT / ARRAY(6000)
      COMMON /SEG   / NSEG,NROW(20),NCOL(20),COSS(20),SINS(20)
     1   ,BTE(20),NWT(20),SPNW(20),XLEW(20),BLE(20),ZLEW(20),ZB(60)
      COMMON /MATCOM/ MATIN
C
      DIMENSION XLE(600),XPT(600),DEL(600),COSTH(600),XBT(600),YBT(600),
     1 ZBT(600),YPT(600),ZPT(600),CHORD(600),DZTOX(600),IT(600),
     2 D(60,60),DELTA(600),DELTI(600)
C
      EQUIVALENCE                      (DEL(1),BLOCK(1))
     1    ,(COSTH(1),BLOCK(601)),       (XBT(1),BLOCK(3901))
     2    ,(YBT(1),BLOCK(4501)),        (ZBT(1),BLOCK(5101))
     3    ,(IT(1),BLOCK(5701)),         (CHORD(1),BLOCK(6301))
     4    ,(DZTOX(1),BLOCK(6901))
     5    ,(XPT(1),ARRAY(1)),           (YPT(1),ARRAY(601))
     6    ,(ZPT(1),ARRAY(1201)),        (D(1),ARRAY(1801))
     7    ,(DELTA(1),ARRAY(2401)),      (DELTI(1),ARRAY(4801))
     7    ,(XLE(1),ARRAY(5401))
      LOGICAL LBC,SUB
C
      MATIN=0
      NMAX=60
CB    EPS=1.E-3
      CALL CPUTIM(TIME0,DT,1)
C
C  READ IN MACH NUMBER AND ANGLE OF ATTACK
C
      READ (5,290) XMACH,ALPHA,PHIR
      ALPHAC=ALPHA
      IF (XMACH.LT.0..OR.XMACH.EQ.EM) RETURN
      IF (IABS(IPRINT).GT.1) WRITE(6,300)
      SUB=XMACH.LT.1.
      BETAM=SQRT(ABS(XMACH*XMACH-1.))
CB    BETAD=1./BETAM
      NBBLOK=0
      NWBLOK=0
      REWIND 8
      REWIND 9
      REWIND 10
```

```
      NPOINT=NCPT
      NPANEL=NBODY+NWING
      IF (NPANEL.EQ.0) RETURN
      REWIND 7
      NCPT=NWING
CB    IF (NWING.EQ.0) GO TO 70
C
C  COMPUTE SIZES OF WING DIAGONAL BLOCKS, THEN
C  COMPUTE CHORDWISE CONTROL POINT LOCATIONS ON WING
C  (PLANAR BOUNDARY CONDITION OPTION ONLY)
C
C  ------------------ INSERT WING BLOCK CODE HERE ----------------------
C
70    EM=XMACH
      NPART=1
      WRITE (6,310) NPART
      WRITE (6,250) NWING,NBODY,NCPT,NSEG
      IF (NSEG.EQ.0) GO TO 75
      WRITE (6,260) NSEG,(NROW(N),N=1,NSEG)
      WRITE (6,270) NSEG,(NCOL(N),N=1,NSEG)
75    CONTINUE
CB    IF (NWING.NE.0) READ (7) ARRAY,CHORD,DZTDX
      IF (NBODY.EQ.0) GO TO 100
      READ (7) ARRAY
      DO 80 N=1,NBODY
      XBT(N)=XPT(N)
      YBT(N)=YPT(N)
      ZBT(N)=ZPT(N)
80    CONTINUE
      NPOINT=NBODY
90    IF (NPART.EQ.1) WRITE (6,320)
C
C  COMPUTE VELOCITY COMPONENTS INDUCED BY BODY PANELS
C
      CALL BODVEL
      CALL CPUTIM(TIME,DT,1)
      WRITE(6,360) TIME,DT,NPART
100   CONTINUE
160   REWIND 8
      REWIND 9
      REWIND 10
      MATIN=1
C
C  WRITE DIAGONAL BLOCKS OF AERODYNAMIC MATRIX ON TAPE 7
C
      IF (NBODY.EQ.0) GO TO 190
      NBBLOK=1
      NBROW(1)=NBODY
      IF (NBODY.LE.NMAX) GO TO 190
      NBBLOK=0
      DO 180 KFU=1,KFUS
      NR=KRADX(KFU)-1
      NC=KFORX(KFU)-1
      DO 180 NN=1,NC
      NBBLOK=NBBLOK+1
      NBROW(NBBLOK)=NR
      DO 170 M=1,NR
      READ (10) (D(M,N),N=1,NR)
170   CONTINUE
      WRITE (7) D
180   CONTINUE
190   CONTINUE
CB    IF (NWING.LE.NMAX.OR.NWING.EQ.0) GO TO 220
```

```
CB    TRANSFER WING DIAGONAL BLOCKS
220   NWBLOK=1
      NWROW(1)=NWING
230   REWIND 7
      REWIND 10
      WRITE (6,280) NBBLOK,NWBLOK
      CALL CPUTIM(TIME,DT,1)
      DT=TIME-TIME0
      WRITE(6,370) TIME,DT
      RETURN
250   FORMAT (7H NWING=,I6,2X,6HNBODY=,I6,2X,5HNCPT=,I6,2X,5HNSEG=,I6)
260   FORMAT (13H NROW(N),N=1,,I4/(1X,20I6))
270   FORMAT (13H NCOL(N),N=1,,I4/(1X,20I6))
280   FORMAT (10X,7HNBBLOK=,I6,2X,7HNWBLOK=,I6)
290   FORMAT (10F7.0)
300   FORMAT(1H1,10X,38HAERODYNAMIC VELCITY MATRIX COMPUTATION,
     *    63X,12H** VELCMP **)
310   FORMAT (/// 12H PARTITION =,I3)
320   FORMAT (26H INFLUENCE OF BODY ON BODY)
360   FORMAT(/10X,18HEND BODVEL,   TIME=,F10.4,5X,3HDT=,F10.4
     *    ,5X,6HNPART=,I3)
370   FORMAT(/10X,18HEND VELCMP,   TIME=,F10.4,5X,3HDT=,F10.4)
      END
```

```
      SUBROUTINE VVELS(NV,YY,ZZ,VX,VY,G,AB,BB,V,W,VRTMAX)
C
C     THIS SUBROUTINE COMPUTES PERTURBATION VELOCITY COMPONENTS DUE TO
C     NV EXTERNAL VORTICES AND THEIR IMAGES INSIDE A BODY WITH
C     ELLIPTICAL CROSS SECTION
C
C
      DIMENSION VX(1),VY(1),G(1)
C
      COMMON/COM1/A2,B2,R2
      COMMON/COM2/SIG2,H2
C
      COMPLEX TO,V1,DSDT,Z,DSDZ,SI,SIB,SO,TAU,CT,VEL
C
      EXTERNAL Z,DSDZ
      PI=3.14159265
      TLC=0.001
      CI=CMPLX(0.0,1.0)
      A2=AB*AB
      B2=BB*BB
      APB=AB+BB
      APB2=APB*APB
      R=0.5*APB
      H2=APB2
      R2=R*R
      SIG2=R2
      TO=CMPLX(YY,ZZ)
      SO=Z(TO)
      V1=CMPLX(0.0,0.0)
      DSDT=DSDZ(SO)
C
C     LOOP OVER THE NUMBER OF VORTICES,NV
C
```

```
      DO 1 I=1,NV
      TAU=CMPLX(VX(I),VY(I))
      SI=Z(TAU)
      SIB=CONJG(SI)
      D=CABS(SI-S0)
      IF(D.LE.TLC) GO TO 2
      V1=V1-G(I)/(S0-SI)
    2 CONTINUE
      D=CABS(S0-R2/SIB)
      IF(D.LE.TLC) GO TO 1
      V1=V1+G(I)/(S0-R2/SIB)
    1 CONTINUE
C
      VEL=0.5*CI*V1*DSDT/PI
      V=REAL(VEL)
      W=-AIMAG(VEL)
      AV=ABS(V)
      AW=ABS(W)
      IF(V.GT.0.0.AND.AV.GE.VRTMAX) V=VRTMAX
      IF(V.LT.0.0.AND.AV.GE.VRTMAX)V=-VRTMAX
      IF(W.GT.0.0.AND.AW.GE.VRTMAX) W=VRTMAX
      IF(W.LT.0.0.AND.AW.GE.VRTMAX)W=-VRTMAX
      RETURN
      END
```

```
      COMPLEX FUNCTION Z(CT)
C
C     THIS FUNCTION SUBROUTINE CALCULATES THE SIGMA VALUE IN THE
C     TRANSFORMED (CIRCLE) PLANE FOR GIVEN TAU IN THE PHYSICAL PLANE
C     FOR AN ELLIPTICAL BODY WITH WINGS
C
      COMMON/COM2/SIG2,R2
      COMMON/COM3/ZR,ZI
      COMMON/COM4/G2,G1
      COMMON/COM6/W2,W
C
C
      COMPLEX W,G1,G2,CT,W2,DBLU
C
      EXTERNAL DBLU
C
      W=DBLU(CT)
      G1=W+SIG2/W
      G2=G1*G1-R2
      Y=AIMAG(G2)
      AY=1.0
      IF(Y.LT.0.0) AY=-1.0
      YZ=AIMAG(G1)
      AYZ=1.0
      IF(YZ.LT.0.0)AYZ=-1.0
      G2=CSQRT(G2)*AY*AYZ
      IF((ABS(YZ).LE.0.0).AND.(REAL(G1).LT.0.0)) G2=CMPLX(-REAL(G2),
     1     AIMAG(G2))
      Z=0.5*(G1+G2)
      IF((ABS(ZI).NE.0.0).AND.(ABS(ZR).NE.0.0)) Z=CMPLX(ZR*ABS(REAL(Z)),
     1ZI*ABS(AIMAG(Z)))
      RETURN
      END
```

APPENDIX L

DESCRIPTION OF PROGRAM VPATH2 AND VPATHL

This appendix is concerned with the description of the vortex chasing programs. They are used to accompany programs DEMON2 and WDYBDY in accordance with the procedures described in section 5 of this report.

Program VPATH2 computes the paths of external vortices along a body with circular cross section with or without cruciform fins attached to it. The configuration can be pitched and rolled. The cruciform fins may have arbitrary deflection angles. Program VPATHL determines the paths of external vortices along a body with elliptical cross section with or without a monoplane wing in the midwing position.

In what follows, the basic theoretical method is described. The geometrical characteristics accounted for in the programs are listed. This is followed by a description of the flow of the programs and program operation. Program limitations and precautions are discussed and the input and output described. Finally program listings are given for programs VPATH2 and VPATHL.

Program Description

The vortex chasing scheme implemented in programs VPATH2 and VPATHL makes use of crossflow plane solutions obtained from slender-body theory. Because of the linear nature of the problem it is possible to superimpose different solutions.

Fundamentally, at given axial stations, velocity components are computed in the crossflow plane at the points occupied by a finite set of external vortices in the presence of a wing-body combination. In this calculation, mutual interaction between the vortices, the interaction between the vortices and the wing-body, the effects of included angle of attack and roll, and fin deflection (if applicable) must be included. Once the lateral velocity components are known, the vortex locations at the next axial station downstream can be determined by means of an integration scheme. The vortices move from one axial station to the next in accordance with the flow angle calculated from the lateral velocity components.

APPENDIX L

Appendix I contains the crossflow plane solutions for 8 different conditions and/or cross sectional shapes. In both programs, the calculation is started at given axial locations (starting station) with a set of vortices with specified strengths and lateral coordinates. The geometry in the crossflow plane is specified a priori and the programs proceed to integrate in the downstream direction to obtain the vortex paths.

Once the vortex paths are calculated over the length of body or body-wing of interest, the programs can calculate velocity components induced by the set of vortices at specified points. In this process, the vortices are taken to be in the presence of the body only, i.e., the lifting surfaces are not accounted for. This approach serves two purposes. First, for wing-body combinations, the effects of the external vortices with known paths induced in the flow tangency condition can be applied at the control points of the constant u-velocity panels laid out over the wings or fins in program DEMON2, Appendix J. Second, the velocity components induced by the external vortices in the presence of the body only are included in the calculation of pressures on the fins and the body surface. Further discussions are given in sections 3.4 and 4.3 of this report.

Geometrical Characteristics

This section describes the geometrical characteristics which can be accounted for by the programs. Since the two programs were written for different cross sections, the geometric details of the configurations will be listed separately for each program.

Program VPATH2

Body:	axisymmetric, constant cross-sectional area
Lifting surfaces:	cruciform fins, each fin planar, may have breaks in sweep, each fin can be arbitrarily deflected

Program VPATHL

Body:	elliptic in cross section, ellipticity constant, may change size of cross section
Lifting surfaces:	monoplane wing in midwing position, may have breaks in sweep

Calculation Procedure

In this section, the sequence of the calculative processes is indicated. The description will be given for both programs simultaneously. Important differences between programs VPATH2 and VPATHL will be pointed out, however.

After reading in the run title, body geometry and wing or fin geometry, the programs proceed to define the side edge of the wing or fin. Flow conditions, the permissible error used in the integration scheme and maximum magnitude of the vortex induced velocity components are then input to both programs. In addition, program VPATH2 reads in the fin deflection angles.

Both programs proceed to read the lateral coordinates of the vortices at the axial station at which they start. The geometrical characteristics of the configuration at hand and flow conditions are written out. Leading- and side-edge vorticity characteristics, if applicable, are then input to both programs. Their influence will be included in the computation of the vortex paths. Program VPATH2 expects this information for 4 fins, program VPATHL expects information for both sides of the monoplane wing.

At the axial station where the vortex path integration is started, program VPATH2 calculates the body radius, the distance from the body centerline to the edge of the lifting surfaces as seen in this crossflow plane. For this and all subsequent axial stations, subroutine SHAPE of program VPATH2 performs this task. For bodies with elliptical cross section (and with constant ellipticity), subroutine SHAPE of program VPATHL computes the horizontal and vertical semiaxes in addition to the distance out to the edge of the monoplane wing as seen in the crossflow plane.

After printing the vortex strengths and the initial vortex coordinates, both programs call on subroutine DASCRU to compute the flow angles at the vortex locations and to determine the vortex locations at the next downstream axial station. To accomplish the former, subroutine DASCRU calls subroutine F. The latter contains calls to subroutines implemented with the various crossflow plane solutions described in Appendix I. The two programs are equipped with different versions of subroutine F on account of the different configurations and/or conditions handled.

Consider program VPATH2 first. It treats a cruciform fin-body combination or body alone. Subroutine F in this program first calculates the lateral velocity components at the vortex points due to angle of attack and roll by calling subroutine PITROL. The crossflow plane solution programmed in PITROL is given in Appendix I, section 2. The source term is omitted in that it leads to unbounded potential at infinity. If two opposite fins are symmetrically deflected, subroutine SYMFIN is called from subroutine F to compute an additional contribution to the velocity components at the vortex points. The crossflow plane solution is given in Appendix I, section 3. If only one fin is deflected or if all fins are arbitrarily deflected, subroutine CRUCI is called by subroutine F to calculate the contribution to the velocity components at the vortex points due to this condition. Then, if edge vorticity associated with the lifting surfaces is specified, its contribution to the velocity components at the vortex points is also computed. Subroutine VVELS is used to accomplish this task. The solution implemented in this subroutine is a specialized adaptation of the solution given in Appendix I, section 1. Finally, subroutine F calls subroutine VOTEX to compute the contributions to the velocity components at each vortex point due to the effect of all vortices in the presence of the cruciform fin-body combination. The solution for this sub problem is given in Appendix I, section 1.

The version of subroutine F in program VPATHL treats elliptical cross sections with or without a monoplane wing. The effects of included angle of attack and roll are calculated by a different version of PITROL. The crossflow plane solution is given in Appendix I, section 6. Provision exists to account for a growing body by the use of subroutine EXPAND. The associated solution is given in Appendix I, section 8. Contributions from specified vorticity associated with the monoplane wing edges are calculated with another version of subroutine VVELS. It employs an adaptation of the solution given in Appendix I, section 5. Finally, the contributory effects due to all vortices, in the presence of the monoplane wing-body, at each vortex location is computed by a call to a different version of subroutine VOTEX. The crossflow plane solution implemented in it is described in Appendix I, section 5. The solutions given in sections 5 and 7 in Appendix I only differ by angles of pitch and sideslip effects.

With the lateral velocities determined by subroutine F at each vortex location and passed back to subroutine DASCRU, the vortices are moved to the next axial station in accordance with the flow angle calculated from the velocity components. The velocity calculation process is repeated and the vortices moved to the next axial station in the downstream direction. This process is repeated until the last axial station, specified in the input, is reached.

Both programs can proceed with the calculation of velocity components in the crossflow plane induced by the vortices at specified points. As mentioned earlier in this appendix, for the purpose of inclusion in the wing boundary condition implemented in program DEMON2, the vortices are considered to be in the presence of the body only.

Program Operation

Programs VPATH2 and VPATHL are written in the FORTRAN IV language (029 punch) and has been run on the CDC 6600 machine belonging to Boeing Computer Services, Inc.. Core requirement is about 60K octal words.

In addition to the standard input (TAPE5) and output (TAPE6) tapes, the program may require additional devices such as disc files or tapes for reading or storing data sets generated when certain options are used. TAPE4 and TAPE7 are used for this purpose. One data set would consist of a set of control-point coordinates and the other would contain a set of perturbation velocities. It should also be noted that these programs contain complex variables.

Running time required by both programs is a function of the length over which the vortex paths are to be calculated and the permissible error E5 specified in the input. As an example, with E5 equal to 0.0001, running time should not exceed 5 seconds for a pitched and rolled configuration with about 8 external vortices including the computation of vortex induced velocity components at 268 field points.

As an aid in debugging and quick visual inspection, both programs are equipped with a simplified plotting capability. They should only be used with few vortices and over a short running length.

APPENDIX L

Program Limitations and Precautions

There are certain limitations associated with the dimension statements programmed in the vortex tracking programs VPATH2 and VPATHL. The number of vortices to be tracked should not exceed 30. One fin of a cruciform fin configuration or one half of a monoplane wing must be described by a maximum of 7 points in planform. This poses a limitation on the number of allowable breaks in sweep. Some care must be exercised in the choice of the permissible error, E5. If its value is orders of magnitude smaller than 10^{-4}, computation time may become unduly long. The number of stations at which the vortex coordinates are printed in the output cannot exceed 50.

Subroutine DASCRU adjusts the integration interval in accordance with the permissible error E5. If for some reason it cannot satisfy the built in criteria for deciding whether or not given stepsize is accurate enough, DASCRU will stop reducing the stepsize after 32 attempts. The program will then stop and register STOP40. A faulty crossflow plane flow field can cause this problem. At times, the problem can be alleviated by reducing the difference between the first and second stations XIP (see input section).

At the present time, program VPATHL is limited to elliptical cross sections with constant ellipticity. Program VPATH2 cannot handle expanding or contracting axisymmetric cross sections.

Both programs may suffer from slight numerical errors when the running length is very long. It is suspected to be caused by errors introduced by the integration scheme in subroutine DASCRU. This behavior can be observed when chasing a set of vortices, initially symmetrically located relative to the free stream vector in the cross flow plane, along an axisymmetric body of considerable length (15 radii long).

A further limitation occurs when a vortex comes very close to the leading edge of a lifting surface. The computer program will tend to move the vortex away from the lifting surface, or it may move along the contour in an unrealistic fashion. This constitutes a limit to the theory used in the programs. In reality, a vortex is made up of a cloud of small vortices with cores in which the lateral velocity components go to zero towards the center. In any event, such a vortex cloud passes right over (and under) the lifting surface in question. It is recommended in such a case to forego the vortex chasing calculation and to assume that the vortex moves back parallel to the body centerline.

Description of Input

This section contains a description of the input for programs VPATH2 and VPATHL. There are some differences in the input on account of the differences in the configurations treated by each program. The input for program VPATH2 will be described first. Then, the description of the input for program VPATHL follows with references made to items of the input for program VPATH2. Listings of all input variables are given at the end of the respective input descriptions.

Input for program VPATH2

Item 1

The first card serves as identification and may contain any alphanumeric information desired. This information is printed on the first page of the output.

Item 2

The second card contains indices concerning the body and lifting-surface geometry, control indices governing the number of axial stations at which information is to be printed, reading in control-point coordinates, writing velocity components, amount of output, and the option to print plots in the program generated output.

Item 3

This card contains the endpoints for each body section for which coefficients describing a meridian will be given (Item 4). Usually, only one endpoint is required; that is, one body section will be considered.

Item 4

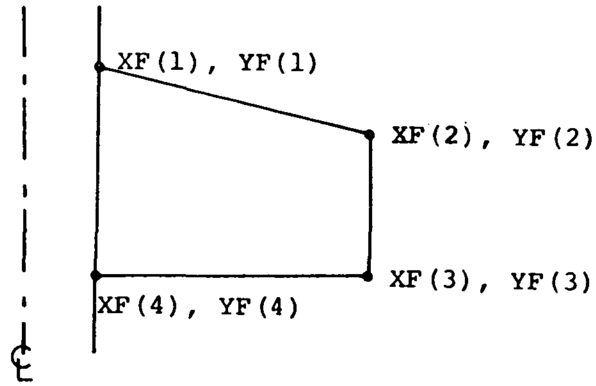
For each body section, a set of coefficients (7 maximum) are specified on this card. They are members of the polynomial shown below and programmed in subroutine SHAPE.

$$\frac{r}{\ell} = C_1 + C_7\sqrt{C_2\ \left(\frac{x}{\ell}\right)^2 + C_3\ \left(\frac{x}{\ell}\right) + C_4} + C_5\ \left(\frac{x}{\ell}\right) + C_6\ \left(\frac{x}{\ell}\right)^2 \qquad \text{(L1)}$$

where C_1 through C_7 are the coefficients, r is the local body radius, and ℓ is the body length. The body length ℓ equals the difference of the endpoints specified in item 3.

Item 5

The coordinates of the fin planform outline corner points are read in if a fin or wing is present. Only one fin or one wing half needs to be described. The XF and YF coordinates are shown in the example shown below; XF is measured from the body nose and YF is measured from the body



centerline. Note: the axial coordinate of the trailing edge of the rootchord must be made to be slightly larger than the axial coordinate of the trailing edge of the side edge.

Item 6

Flow conditions and fin deflection angles, if applicable, are specified on this card. In addition, the permissible error, E5, used as a criterion in the integration scheme programmed in subroutine DASCRU is read in. Note: E5 must not be taken too small or the running time required may become unduly large. This card also reads in the upper bound, VRTMAX, imposed on the magnitude of the vortex induced velocity components.

Item 7

The number of vortices at the axial stations to be specified in item 9 are read in by this card. This arrangement allows for the introduction of additional vortices. This information must be supplied for increasing axial location (x_B-station).

Item 8

The starting coordinates, in the crossflow plane with y_B to the right and z_B upwards (i.e. the body coordinate system shown in figure 1), and strengths of the vortices are read in by these cards. If additional vortices are to be accounted for, the starting coordinates and strengths are read in at this time also. This information must be supplied for increasing axial location in synchronization with the number of vortices of item 7 and the axial station of item 9. Note that coordinates VX($=y_B$) and VY($=z_B$) are dimensional.

Item 9

These cards contain the axial stations at which the program will print vortex coordinates. Also, these stations are chosen such that they coincide with the introduction of additional vortices, if applicable, see items 7 and 8.

Item 10

This and the next three items read in specifications describing leading- and side-edge vorticity characteristics. They are obtained from the results calculated by program DEMON2 described in Appendix J of this report. This card contains the number of stations in the spanwise direction at which leading-edge vorticity locations and strengths are to be specified. This information must be supplied for all 4 fins of a cruciform configuration.

Item 11

If the information of item 10 is read in as nonzero, the locations along the leading edge and the strength of the leading-edge vorticity are read in. Note that the dimensional quantity XLE is measured in the wing coordinate system, as calculated by program DEMON2, not the body coordinate system. This information must be supplied for all fins.

Item 14

This optional input is specified when NCPIN of item 2 is read in as zero. The number NCP is the number of field points at which vortex induced velocity components are to be computed on the basis of the vortices being in the presence of the body only.

Item 15

If the information of item 14 is nonzero, these cards contain the coordinates, in the body coordinate system, if the fieldpoints at which vortex induced effects are to be computed. Note: in connection with the use of programs VPATH2 and VPATHL together with program DEMON2, index NCPIN is set equal to 1 and the information of items 14 and 15 is read in by means of a data set stored on TAPE4.

INPUT VARIABLES FOR PROGRAM VPATH2
(Circular Cross Section Bodies With Cruciform Fins)

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
Item 1	(20A4)	Any alphanumeric information to identify the run.
Item 2	(8I10)	
NS		Number of body sections for which coefficients C(I,J) are required, $1 \leq NS \leq 7$.
NF		Number of corner points used to define fin geometry, $1 \leq NF \leq 7$.
NIP		Number of axial stations to be printed in output, $1 \leq NIP \leq 50$.
NCPIN		NCPIN = 1 Read in control point and body pressure points from data set (TAPE4). NCPIN = 0 No input.
NVLOUT		NVLOUT = 1 Write velocities induced by moving vortices (and calculated in this program) on data set (TAPE7). NVLOUT = 0 No input.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
NOUT		NOUT = 1 Print additional output. NOUT = 0 Minimum output.
IPLT		IPLT = 0 No plots showing vortex positions in the output. IPLT = 1 Vortex positions shown in crossflow planes.
Item 3	(7F10.5)	
XE(I)	$x_{B,i}$	Axial coordinate of the end of each body section, $1 \leq I \leq NS$.
Item 4	(7F10.5)	
C(I,J)	C_{ij}	Coefficients in the body meridian equation, $1 \leq I \leq NS$, $1 \leq J \leq 7$.
Item 5	(8F10.5)	Optional input concerning fin planform geometry when $NF \neq 0$.
XF(I)	$x_{B,i}$	Axial coordinate of fin corner point, $1 \leq I \leq NF$.
YF(I)	$y_{B,i}$	Lateral coordinate of fin corner point, $1 \leq I \leq NF$.
Item 6	(8F10.5)	
ALFAC	α_c	Included angle of attack, measured between free-stream velocity vector and body centerline.
PHI	ϕ	Angle of roll, positive right fin down.
D1	δ_1	Deflection angle of upper vertical fin, positive: trailing edges to right, degrees.
D2	δ_2	Deflection angle of right horizontal fin, positive: trailing edge down, degrees.
D3	δ_3	Deflection angle of lower vertical fin, positive: trailing edge to right, degrees.
D4	δ_4	Deflection angle of left horizontal fin, positive: trailing edge down, degrees.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
E5		Error allowed in integration subroutine DASCRU. Use the value 0.0001 or less.
VRTMAX		Maximum magnitude of vortex induced velocities, use the value 0.35.
Item 7	(16I5)	
NVV(I)		Total number of vortices at each axial station, $1 \le I \le NIP$, NVMAX = NVV(NIP).
Item 8	(6F10.5)	Starting coordinates of the vortices.
VX(I)	y_B	y_B-coordinate of vortex I.
VY(I)	z_B	z_B-coordinate of vortex I.
G(I)	$\frac{\Gamma_V}{V_\infty}$	Vortex strength, counterclockwise positive (when viewing forward), $1 \le I \le NVMAX$, NVMAX = NVV(NIP).
Item 9	(8F10.5)	
XIP(I)	$x_{B,i}$	Axial station at which output is required, $1 \le I \le NIP$.
Item 10	(8I10)	
MSWR		Number of leading-edge vortex information stations for right horizontal fin.
MSWL		Number of leading-edge vortex information stations for the left horizontal fin.
MSWU		Number of leading-edge vortex information stations for the upper vertical fin.
MSWD		Number of leading-edge vortex information stations for the lower vertical fin.
		NEDGV = MSWR + MSWL + MSWU + MSWD.
Item 11	(6F10.5)	Optional input when NEDGV $\neq$ 0.
XLE(JLE)	$x_{W,LE}$	Wing x-coordinate of station on fin leading edge.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
CGLOC(JLE)	$\bar{y}_{LE}$, $\bar{z}_{LE}$	Center of gravity of the leading-edge vorticity distribution at $x_{w,LE}$.
GAMLE(JLE)	$\frac{\Gamma_{LE}}{V_\infty}$	Strength of the vorticity distribution at XLE(JLE). $1 \leq$ JLE $\leq$ NEDGV.
Item 12	(I10)	
NCW		Number of side-edge vortex information stations. Same for all fins. NSIDGE = 4 (NCW).
Item 13	(6F10.5)	Optional input when NSIDGE $\neq$ 0.
XSE(JSE)	$x_{w,SE}$	Wing x-coordinate of station on fin side edge
CGSELC(JSE)	$\bar{y}_{SE}$, $\bar{z}_{SE}$	Center of gravity of side-sdge vorticity distribution at $x_{w,SE}$.
GAMSE(JSE)	$\frac{\Gamma_{SE}}{V_\infty}$	Strength of vorticity distribution at XSE(JSE). $1 \leq$ JSE $\leq$ NSIDGE.
Item 14	(I10)	Next two items are optional input for NCPIN = 0, only.
NCP		Number of control points and body pressure points or field points at which vortex induced velocities are calculated.
Item 15	(3F10.5	Optional input when NCP $\neq$ 0 specifying field point coordinates.
CPX	x_B	Body x-coordinate of field point.
CPY	y_B	Body y-coordinate of field point.
CPZ	z_B	Body z-coordinate of field point.

APPENDIX L

Input for program VPATHL

Item 1

Refer to input item 1 under program VPATH2.

Item 2

Refer to input item 2 under program VPATH2. Only difference is option to set optional output plot size. The bounds read in as item 4 below.

Item 3

This card specifies the inverse of the ellipticity ratio of the elliptical cross section under consideration. This ratio is a constant for all axial locations.

Item 4

Refer to input item 3 under program VPATH2.

Item 5

Refer to input item 4 under program VPATH2. The polynomial is used to describe the meridian associated with the horizontal semiaxis of an elliptical cross section.

Item 6

Refer to input item 5 under program VPATHL.

Item 7

If IPLT equals 1 in item 2, the maximum and minimum values of the lateral coordinates are read in by this card. Now, XMAX and XMIN pertain to y_B coordinate and YMAX and YMIN pertain to z_B coordinate of the body coordinate system, see figure 1.

Item 8

Refer to input item 6 under program VPATH2. Omit deflection angles.

Item 9

Refer to item 7 under program VPATH2.

Item 10

Refer to item 8 under program VPATH2.

Item 11

Refer to item 9 under program VPATH2.

Item 12

Refer to item 10 under program VPATH2. Only MSWR and MSWL need be specified since the lifting surface is a monoplane wing designated as right and left "fins".

Item 13

Refer to item 11 under program VPATH2. Here, leading-edge vorticity characteristics need only be specified for the right and left "fins".

Item 14

Refer to item 12 under program VPATH2. Here NSIDGE = 2 NCW.

Item 15

Refer to item 13 under program VPATH2. In this instance, this information is only specified for the side edges of the right and left "fins".

Item 16

Refer to item 14 under program VPATH2.

Item 17

Refer to item 15 under program VPATH2.

INPUT VARIABLES FOR PROGRAM VPATHL
(Elliptical Cross Section Bodies With Monoplane Wing)

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
Item 1	(20A4)	Any alphanumeric information to identify the run.

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS	
Item 2	(8I10)		
NS		Number of body sections for which coefficients C(I,J) are required, $1 \leq NS \leq 7$.	
NF		Number of corner points used to define fin geometry, $1 \leq NF \leq 7$.	
NIP		Number of axial stations to be printed in output, $1 \leq NIP \leq 50$.	
NCPIN		NCPIN = 1	Read in control point and body pressure points from data set (TAPE4).
		NCPIN = 0	No input.
NVLOUT		NVLOUT = 1	Write velocities induced by moving vortices (and calculated in this program) on data set (TAPE7).
		NVLOUT = 0	No output on data set.
NOUT		NOUT = 0	Minimum output.
		NOUT = 1	Some additional debug output.
		NOUT = 2,3	Large amount of debug output containing information about intermediate complex variables. (use only when NIP = 2)
IPLT		IPLT = 0	No plots showing vortex positions in the output.
		IPLT = 1	Specify maximum and minimum x and y to be used in the plots, also see Item 4.
		IPLT = 3	Program determines plot size.
Item 3	(F10.5)		
BFACT	$1/\varepsilon$	Ratio of vertical semiaxis over horizontal semiaxis.	
Item 4	(7F10.5)		
XE(I)	$x_{B,i}$	Axial coordinate of the end of each body section, $1 \leq I \leq NS$.	

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
Item 5	(7F10.5)	
C(I,J)	C_{ij}	Coefficients in the body meridian equation, $1 \le I \le NS$, $1 \le J \le 7$.
Item 6	(8F10.5)	Optional input concerning fin planform geometry when NF $\neq$ 0.
XF(I)	$x_{B,i}$	Axial coordinate of fin corner point, $1 \le I \le NF$.
YF(I)	$y_{B,i}$	Lateral coordinate of fin corner point, $1 \le I \le NF$.
Item 7	(8F10.5)	Optional input required when IPLT = 1 in Item 2.
XMAX		Maximum x-value used in program generated plots in output.
XMIN		Minimum x-value used in program generated plots in output.
YMAX		Maximum y-value used in program generated plots in output.
YMIN		Minimum y-value used in program generated plots in output.
Item 8	(8F10.5)	
ALFAC	α_c	Included angle of attack, measured between free-stream velocity vector and body centerline.
PHI	ϕ	Angle of roll, positive right fin down.
E5		Error allowed in integration subroutine DASCRU. Use the value 0.0001 or less.
VRTMAX		Maximum magnitude of vortex induced velocities, if VRTMAX = 0, the value 0.35 is used.
Item 9	(16I5)	
NVV(I)		Total number of vortices at each axial station, $1 \le I \le NIP$, NVMAX = NVV(NIP).

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
Item 10	(6F10.5)	Initial vortex positions in crossflow plane.
VX(I)	$y_{B,i}$	y_B-coordinate of vortex I.
VY(I)	$z_{B,i}$	z_B-coordinate of vortex I.
G(I)	$\frac{\Gamma_{V,i}}{V_\infty}$	Vortex strength, counterclockwise positive (when viewing forward), $1 \leq I \leq$ NVMAX, NVMAX = NVV(NIP).
Item 11	(8F10.5)	
XIP(I)	$x_{B,i}$	Axial station at which output is required, $1 \leq I \leq$ NIP.
Item 12	(8I10)	
MSWR		Number of leading-edge vortex information stations for right horizontal fin.
MSWL		Number of leading-edge vortex information stations for the left horizontal fin. NEDGV = MSWR + MSWL
Item 13	(6F10.5)	Optional input when NEDGV $\neq$ 0.
XLE(JLE)	$x_{w,LE}$	Wing x-coordinate of station on fin leading edge.
CGLOC(JLE)	$\bar{y}_{LE}, \bar{z}_{LE}$	Center of gravity of the leading-edge vorticity distribution at $x_{w,LE}$.
GAMLE(JLE)	$\frac{\Gamma_{LE}}{V_\infty}$	Strength of the vorticity distribution at XLE(JLE). $1 \leq$ JLE $\leq$ NEDGV
Item 14	(I10)	
NCW		Number of side-edge vortex information stations. Same for all fins. NSIDGE = 2 (NCW).

PROGRAM VARIABLE	ALGEBRAIC SYMBOL (IF APPLICABLE)	COMMENTS
Item 15	(6F10.5)	Optional input when NSIDGE $\neq$ 0.
XSE(JSE)	$x_{w,SE}$	Wing x-coordinate of station on fin side edge.
CGSELC(JSE)	$\bar{y}_{SE},\bar{z}_{SE}$	Center of gravity of side-edge vorticity distribution at $x_{w,SE}$.
GAMSE(JSE)	$\frac{\Gamma_{SE}}{V_\infty}$	Strength of vorticity distribution at XSE(JSE). 1 $\leq$ JSE $\leq$ NSIDGE
Item 16	(I10)	Next two items are optional input for NCPIN = 0, only.
NCP		Number of control points and body pressure points or field points at which vortex induced velocities are to be calculated.
Item 17	(3F10.5)	Optional input when NCP $\neq$ 0 specifying field point coordinates.
CPX	x_B	Body x-coordinate of field point.
CPY	y_B	Body y-coordinate of field point.
CPZ	z_B	Body z-coordinate of field point.

Description of Output

This section describes the output generated by programs VPATH2 and VPATHL. Only a few items in the output of these programs are different as pointed out below. The output to be described is generated when print control index NOUT is set equal to zero. For nonzero values, large amounts of additional output results. Thus, other than for debugging purposes, index NOUT must be set equal to zero in item 2 of the input for both programs. The results of the output plot options are self evident and will not be discussed here.

The first page of output contains the run identification and the geometry of the fin or wing planform. Included angle of attack and roll are printed. Program VPATH2 also gives the deflection angles of the fins, if applicable. The permissible error in the integration scheme is specified. This output is followed by a list of vortex coordinates in the crossflow plane as a function of increasing axial location. Quantity Y,VRTX is y_B and Z,VRTX is z_B, both in the body coordinate system, refer to figure 1. The vortex strengths divided by the free-stream velocity, GAMMA/VINF, are also indicated. This information is given for each of the output stations, XIP, specified in the input and printed as X. At each station, the local body geometry and semispan (distance from body centerline to edge of fin or wing as seen in the crossflow plane) are written. Program VPATH2 gives the local body radius for the axisymmetric body. Program VPATHL specifies the local horizontal semiaxis and the vertical semiaxis.

The final item in the output of both programs are the coordinates of field points (or control points), read in by means of input or data set, and the velocity components induced by the vortices at the points. The coordinates and the velocity components are given in the body coordinate system, refer to figure 1. The vortex effects are calculated on the basis of the vortices in the presence of the body only.

Program Listings

Programs VPATH2 and VPATHL are written in FORTRAN IV (029 punch) computer language for the CDC 6600 computer. Program VPATH2 consists of a main routine, VPATH, and 12 subroutines. Program VPATHL consists of a main routine, VPATHL, and 13 subroutines. The listings are shown on the indicated pages with the main program first and the subroutines following in alphabetical order.

PROGRAM VPATH2

PROGRAM VPATH2

```
      PROGRAM VPATH(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE4,TAPE7)
C
C     VERSION: VPATH2
C
C         THIS PROGRAM COMPUTES THE PATHS AND VORTEX INDUCED CROSSFLOW
C     VELOCITIES AT SPECIFIED FIELD POINTS FOR A SET OF VORTICES IN THE
C     PRESENCE OF A WING-BODY COMBINATION AT ANGLE OF ATTACK AND ROLL. ANY
C     OR ALL OF THE FINS MAY BE DEFLECTED.  SLENDER BODY THEORY IS USED
C     IN THE COMPUTATION OF THE CROSSFLOW VELOCITIES.
C
C
C   THE COORDINATE SYSTEM USED HERE IS THE BODY COORDINATE SYSTEM
C   WITH THE X-AXIS ALONG THE BODY CENTER-LINE STARTING AT THE NOSE TIP,
C      Y-AXIS TO THE RIGHT WHEN LOOKING FORWARD,Z-AXIS UP.
C
C          WHEN FINS ARE PRESENT,THE Y-AXIS FALLS ALONG RIGHT FIN,
C      THE Z-AXIS ALONG THE UPPER FIN.  THUS,THIS PROGRAM PERFORMS ALL
C      VORTEX PATH CALCULATIONS IN A ROLLED COORDINATE SYSTEM.
C
C   *********NOTE: CRUCIFORM FINS ONLY*****************
C
C
      DIMENSION TITLE(20),XO(60),XIP(50),WK(120)
      DIMENSION VXP(30,30,2),NVV(30)
C
      COMMON/VEL/AL,RE,D1,D2,D3,D4,VX(30),VY(30),G(30),NV,NDEL,NS,NF,
     1XE(7),XF(7),YF(7),C(7,7),IFIN
      COMMON/BLK2/AC,PHI
      COMMON/FINLE/XLE(80),CGLOC(80),GAMLE(80),NSWR,NSWL,NSWU,NSWD,
     1 NEDGV,XTIPLE
      COMMON/SIDEDG/XSE(80),CGSELC(80),GAMSE(80),NCW,NSIDGE,XTIPTE
      COMMON XPLT(30,52),YPLT(30,52),ZPLT(30,52),NPLT(52),ROT(3)
     *   ,XP2(17,18),YP2(17,18)
C
      NAMELIST/DEBUG/NS,NF,NIP,NCRIN,NVLOUT,NOUT,VRTMAX,XF,C,XE,YF,NVV
C
    1 FORMAT(20A4)
    4 FORMAT(8I10)
    5 FORMAT(7F10.5)
    6 FORMAT(8F10.5)
    7 FORMAT(6F10.5)
    9 FORMAT (/5X,20HLOCAL BODY RADIUS = ,F10.5,5X,
     1 20HLOCAL SEMI SPAN S = ,F10.5/)
   11 FORMAT (//5X,33H INCLUDED ANGLE OF ATTACK(DEG) = ,F10.5,
     1 24H     ROLL ANGLE(DEG)  = ,F10.5/)
   12 FORMAT (2X,24H        PANEL DEFL.(DEG) :,//9X,9H DELTA1= ,F6.3,
     1 11H   DELTA2= ,F6.3,11H   DELTA3= ,F6.3,11H   DELTA4= ,F6.3//)
   21 FORMAT(//19H         X-STATION NO.,I3,9H        Y=,F6.3,6X,
     1 25H INTEGRATION STEP SIZE = ,F10.5//)
   22 FORMAT(I15,4X,2E17.5,E15.5)
   25 FORMAT (////10X,38HVORTEX COORDINATES IN CROSS-FLOW PLANE.//)
   26 FORMAT (//43H             INITIAL VORTEX POSITIONS AT    X = ,F6.3/)
   27 FORMAT (10X,7H VORTEX,10X,7H Y,VRTX,10X,7H Z,VRTX,6X,
     1   10HGAMMA/VINF/)
   30 FORMAT(16I5)
   31 FORMAT(/// 6X,76HCROSSFLOW VELOCITIES AT CONTROL POINTS INDUCED BY
     1 VORTICES AND THEIR IMAGES ,//
     1 6X,2HIC,10X,6HX,BODY,10X,6HY,BODY,10X,6HZ,BODY,10X,1HV,15X,1HW)
   32 FORMAT(5X,I5,6X,5E15.5)
   60 FORMAT(3F10.5)
  700 FORMAT (//5(1H*), 59HPERMISSIBLE RELATIVE ERROR,E5,USED IN INTEGRA
     1TION SCHEME = ,E12.5/)
  701 FORMAT (////5(1H*),61HSUBROUTINE DASCRU CAN NOT OBTAIN VALUE FOR I
```

```
     INTEGRATION STEP H,5(1H*)/////)
  702 FORMAT (85X,I3,2F10.5)
  703 FORMAT (//85X,31HINTERPOLATED VORTEX COORDINATES/87X,1HI,5X,
     1  2HYV,10X,2HZV/)
  704 FORMAT (////17X,12HFIN GEOMETRY/10X,12HFIN SEMISPAN,11X,1H=,1X,
     A F10.5/
     1        10X,25HFIN ROOTCHORD            = ,F10.5/
     8        10X,25HFIN ROOT L.E. X-STATION= ,F10.5/
     2        10X,25H         L.E. Y-STATION= ,F10.5/
     3        10X,25HFIN TIP L.E. X-STATION = ,F10.5/
     4        10X,25H        L.E. Y-STATION = ,F10.5/
     5        10X,25HFIN TIP T.E. X-STATION = ,F10.5/
     6        10X,25H        T.E. Y-STATION = ,F10.5/
     8        10X,25HFIN ROOT T.E. X-STATION= ,F10.5/
     9        10X,25H         T.E. Y-STATION= ,F10.5,////)
  705 FORMAT (6X,I2,2X,F10.5,1X,F10.5,1X,F10.5)
  706 FORMAT (////10X,26HFIN LEADING EDGE VORTICITY/
     1 5X,3HJLE,6X,1HX,7X,10HY OR Z BAR,2X,11HGAMMA/VINF,/)
  707 FORMAT (////10X,23HFIN SIDE EDGE VORTICITY/5X,3HJSE,6X,1HX,7X,
     1    10HY OR Z BAR,2X,11HGAMMA/VINF,/)
  745 FORMAT (I5,3E12.5)
  746 FORMAT (I5,5E12.5)
C
C
C
      RAD=3.1415926/180.
C
C
C         .........  INPUT  ..........
C
   99 READ(5,1)TITLE
      IF(EOF(5))2,3
    3 CONTINUE
C
C  .. GEOMETRY ..
C
C
C         NS== OF BODY SECTIONS WITH DIFFERENT GEOMETRY
C         NF= = OF CORNER POINTS OF CRUCIFORM WING SECTIONS
C         NIP= = OF X- STATIONS PRINTED IN OUTPUT
C         XE= X VALUES AT THE END OF EACH BODY SECTION
C         C= COEFFICIENTS IN THE BODY GEOMETRY EQUATION
C         XF,YF= X AND Y COODS OF THE FIN BREAK IN SWEEP POINTS.
C  NOTE: HERE FINS ARE NUMBERED 1=TOP, 2=RIGHT, 3=BOTTOM, 4=LEFT.
C
      READ(5,4)NS,NF,NIP,NCPIN,NVLOUT,NOUT,IPLT
      READ(5,5)(XE(I),I=1,NS)
      READ(5,5)((C(I,J),J=1,7),I=1,NS)
      IF(NF.NE.0) READ(5,6)(XF(I),YF(I),I=1,NF)
C
C
C     DETERMINE DISTANCE FROM BODY CENERLINE TO FIN TIP(=SEMISPAN)
C     AND X-LOCATIONS OF FIN TIP LEADING EDGE AND TRAILING EDGE.
C
      IF (NF.EQ.0) GO TO 84
      YMAX=0
       CRP=SQRT((XF(NF)-XF(1))*(XF(NF)-XF(1))+(YF(NF)-YF(1))*(YF(NF)-
     1 YF(1)))
      DO 80 I=1,NF
      IF (YF(I).GT.YMAX) YMAX=YF(I)
   80 CONTINUE
      NFM1=NF-1
      DO 81 I=1,NFM1
```

```
      IP1=I+1
      IF (YF(I).EQ.YMAX.AND.YF(IP1).EQ.YMAX) GO TO 82
      IF (YF(I).EQ.YMAX) GO TO 83
   81 CONTINUE
      GO TO 84
   82 IMAX=I
      IMAXP1=I+1
      XTIPLE=XF(IMAX)
      YTIPLE=YF(IMAX)
      XTIPTE=XF(IMAXP1)
      YTIPTE=YF(IMAXP1)
      GO TO 84
   83 XTIPLE=XF(IMAX)
      XTIPTE=XTIPLE
   84 CONTINUE
C
C
C
C        ALFAC =INCLUDED ANGLE OF ATTACK,  PHI=ROLL ANGLE BOTH IN DEGREE
C        D1,D2,D3,D4 ARE FIN DEFLECTIONS IN DEGREES, POSITIVE TRAILING
C        EDGE DOWN FOR HOR. FINS,TRAILING EDGE TO THE RIGHT FOR VERT.
C        FINS
C        E5 = PERMISSIBLE RELATIVE ERROR IN THE PATH INTEGRATION SCHEME
C
      READ(5,6)ALFAC,PHI,D1,D2,D3,D4,E5,VRTMAX
      IF (VRTMAX.EQ.0.0) VRTMAX=0.35
      HI=ABS(D1)+ABS(D2)+ABS(D3)+ABS(D4)
      MDEL=0
      IF (HI.NE.0.0) MDEL=1
C
C  .. X-STATIONS,INTEGRATION INFO, + INITIAL VORTEX POSITIONS AND STRENG
C
C
C        NVV = TOTAL NUMBER OF VORTICES AT EACH X-STATION
C
C
      READ(5,30)(NVV(I),I=1,NIP)
      NV=NVV(1)
      NVMAX=NVV(NIP)
C
C        READ IN CROSSFLOW STARTING COORDINATES AND STRENGTHS FOR ALL
C        VORTICES REGARDLESS OF THE X-STATION AT WHICH THEY START.
C        THIS INFO MUST BE INPUT FOR INCREASING X-STATION.
C
C     HERE....VX(I)..Y-COORDINATE
C             VY(I)..Z-COORDINATE
C             G(I)...GAMMA/VINF,COUNTERCLOCKWISE POSITIVE,
C                    WHEN VIEWING FORWARD.
C
      READ(5,7)(VX(I),VY(I),G(I),I=1,NVMAX)
      DO 8 I=1,NV
      J=2*I-1
      K=J+1
      VXP(1,I,1)=VX(I)
      VXP(1,I,2)=VY(I)
      XO(J)=VX(I)
    8 XO(K)=VY(I)
C
C        XIP= X- VALUES AT THE NIP X-STATIONS AT WHICH OUTPUT REQD.
C        FIRST VALUE FOR XIP CAN BE ANY NUMBER LARGER THAN ZERO
C        INTEGRATION STARTS AT XIP(1)
C        INTEGRATION STEP SIZE DETERMINED BY DASCRU...H
C
```

```
      READ(5,6)(XIP(I),I=1,NIP)
C
C
      WRITE(6,1)TITLE
      IF (NF.NE.0)
     1WRITE (6,704) YMAX,CRR,XF(1),YF(1),XTIPLE,YTIPLE,XTIPTE,YTIPTE,
     1 XF(NF),YF(NF)
      WRITE(6,11)ALFAC,PHI
      WRITE(6,12)D1,D2,D3,D4
      IF (NOUT.NE.0) WRITE (6,DEBUG)
C
C
C     READ NUMBERS OF FIN LEADING EDGE VORTEX INFO STATIONS XLE FOR
C     EACH FIN.
C     FOR EACH XLE STATION,READ IN YBAR OR ZBAR(=CGLOC) AND STRENGTH
C     OF THE VORTICITY DISTRIBUTION.
C  NOTE: THIS VORTICITY IS FIXED IN POSITION,IT AFFECTS THE FLOWFIELD
C
C  NOTE: XLE AND XSE ARE READ IN IN THE FIN COORDINATE SYSTEM AND
C     MUST BE TRANSFORMED TO BODY COORDINATE SYSTEM.
C
      READ (5,4) MSWR,MSWL,MSWU,MSWD
      NEDGV=MSWR+MSWL+MSWU+MSWD
      IF (NEDGV.EQ.0) GO TO 19
                         READ (5,7) (XLE(IFV),CGLOC(IFV),GAMLE(IFV),
     1  IFV=1,NEDGV)
      WRITE (6,706)
      DO 15 JLE=1,NEDGV
      XLE(JLE)=XLE(JLE)+XF(1)
   15 WRITE (6,705) JLE,XLE(JLE),CGLOC(JLE),GAMLE(JLE)
   19 CONTINUE
C
C     READ NUMBER OF FIN SIDE EDGE VORTEX INFO STATIONS XSE FOR EACH
C     FIN.
C  NOTE: THIS VORTICITY IS FIXED IN POSITION,IT AFFECTS THE FLOWFIELD
C     FOR EACH XSE STATION,READ IN YBAR OR ZBAR(=CGSELC) AND THE
C     STRENGTH OF THE VORTICITY DISTRIBUTION
C
      READ (5,4) NCW
      NSIDGE=4*NCW
      IF (NSIDGE.EQ.0) GO TO 18
                          READ (5,7) (XSE(JSE),CGSELC(JSE),GAMSE(JSE),
     1 JSE=1,NSIDGE)
      WRITE (6,707)
      DO 16 JSE=1,NSIDGE
      XSE(JSE)=XSE(JSE)+XF(1)
   16 WRITE (6,705) JSE,XSE(JSE),CGSELC(JSE),GAMSE(JSE)
   18 CONTINUE
C
C
      WRITE (6,700) ES
      WRITE (6,25)
      WRITE(6,26)XIP(1)
      CALL SHAPE (XIP(1),RLOC,SLOC)
      WRITE (6,9) RLOC,SLOC
      WRITE(6,27)
      WRITE(6,22)(L,VX(L),VY(L),G(L),L=1,NV)
C
C        CONVERT ANGLES TO RADIANS
C
      AC=ALFAC*RAD
      BE=PHI*RAD
      PHI=BE
```

```
      D1=D1*RAD
      D2=D2*RAD
      D3=D3*RAD
      D4=D4*RAD
      AL=ASIN(SIN(AC)*COS(BE))
      BE=ASIN(SIN(AC)*SIN(BE))
C
C   ......COMPUTE VORTEX PATHS USING DASCRU INTEGRATION SUBROUTINE......
C
      NIP1=NIP-1
      H=XIP(2)-XIP(1)
      DO 20 I=1,NIP1
      I1=I+1
      NV=NVV(I)
      NVN=NVV(I1)
      NV1=NV+1
      N=2*NV
      A1=XIP(I)
      B1=XIP(I+1)
C
      CALL DASCRU(A1,B1,H,N,XO,WK,IER,ES,VRTMAX)
C
C        IF IER GREATER THAN 32,DASCRU HAD TROUBLE GETTING STEP SIZE.
C        THEN,RATHER THAN CONTINUING WITH THE INTEGRATION, STOP 40
C        REDUCE XIP(2)-XIP(1)AND RERUN
C
      IF (IER.GE.32) GO TO 28
      GO TO 29
   28 WRITE (6,701)
      STOP 40
   29 CONTINUE
C
C
C   .. ADD THE NEW VORTICES AND THEIR POSITIONS FOR THE NEXT X-INTERVAL
C
      IF(NVN.EQ.NV)GO TO 39
      DO 35 K1=NV1,NVN
      JL=2*K1-1
      KK=JL+1
      XO(JL)=VX(K1)
   35 XO(KK)=VY(K1)
   39 CONTINUE
C
C   .. OUTPUT VORTEX POSITIONS AND CONFIGURATION CHARACTERISTICS AT THIS
C      STATION.
C
      WRITE(6,21)I1,B1,H
      CALL SHAPE (B1,BLOC,SLOC)
      WRITE (6,9) BLOC,SLOC
      WRITE(6,27)
      DO 23 L=1,NVN
      J=2*L-1
      K=J+1
      VXP(I1,L,1)=XO(J)
      VXP(I1,L,2)=XO(K)
      WRITE(6,22)L,XO(J),XO(K),G(L)
C
C  SAVE VORTEX LOCATION FOR PLOT
C
      JCV=NIP1+L+1
      XPLT(I,JCV)=B1
      YPLT(I,JCV)=XO(J)
      ZPLT(I,JCV)=XO(K)
```

```
   23 CONTINUE
C
C  SAVE BODY POINTS FOR PLOT
C
      XPLT(1,I1)=B1
      YPLT(1,I1)=RLOC
      ZPLT(1,I1)=RLOC
      YPLT(2,I1)=SLOC
   20 CONTINUE
C
C  PLOT VORTEX LOCATIONS
C
      XPLT(1,1)=XIP(1)
      IF (IPLT.GT.0)
     * CALL PLOTVH(XPLT,YPLT,ZPLT,NPLT,NIP1,NVN,30,ROT,XF,YF,NF,XP2,YP2)
C
C..COMPUTE VELOCITIES AT THE SPECIFIED CONTROL POINTS INDUCED BY NV
C    EXTERNAL VORTICES AND THEIR IMAGES.
C
C
C  NOTE: IF CONTROL POINTS ARE PASSED THROUGH BY MEANS OF A DATA SET
C      I.E. WHEN NCPIN IS NOT EQUAL TO 0,    INDEX NCP IS READ IN FROM
C      THE DATA SET ALSO.
C  NOTE:X-COORDINATE OF CONTROL POINT MUST THEN BE TRANSFORMED TO BODY
C      COORDINATE SYSTEM.
C      THIS IS DONE BELOW.
C
C
      NCP=0
      IF (NCPIN.NE.0) REWIND 4
      IF (NVLOUT.NE.0) REWIND 7
      IF (NCPIN.EQ.0) GO TO 72
      IF (NCPIN.NE.0) READ (4,745) NCP
      IF (EOF(4).NE.0) GO TO 99
      GO TO 73
   72 READ (5,4) NCP
   73 CONTINUE
      IF(NCP.EQ.0)GO TO 99
      WRITE(6,31)
      DO 69 J11=1,NCP
      IF (NCPIN.EQ.0) GO TO 70
      READ (4,745) IC,CPX,CPY,CPZ
      CPX=CPX+XF(1)
      GO TO 71
   70 READ(5,60)CPX,CPY,CPZ
   71 CONTINUE
C
C.. DETERMINE THE X-STATIONS ADJACENT TO THE CONTROL POINT
C
      DO 61 I=1,NIP
      IF (CPX.LT.XIP(1)) GO TO 69
      J=I-1
      IF (I.EQ.1) J=1
      IF(CPX.LE.XIP(I))GO TO 62
   61 CONTINUE
C
C  DETERMINE BY INTERPOLATION THE POSITION IN THE CROSSFLOW PLANE OF ALL
C      VORTICES AT EACH STATION CPX.
C
   62 K=J+1
      X1=XIP(J)
      X2=XIP(K)
      AT1=(X2-CPX)/(X2-X1)
```

```
      WT2=(CPX-X1)/(X2-X1)
      NV=NVV(J)
      CALL SHAPE (CPX,RB,SL)
      IF (JOUT.NE.0) WRITE (6,703)
      DO 63 I=1,NV
      VX(I)=WT1*VXP(J,I,1)+WT2*VXP(K,I,1)
      VY(I)=WT1*VXP(J,I,2)+WT2*VXP(K,I,2)
      IF (NOUT.EQ.0) GO TO 63
      WRITE (6,702) I,VX(I),VY(I)
   63 CONTINUE
C
C     SUBROUTINE VVELS CALCULATES VORTEX VELOCITIES INCLUDING EFFECTS
C     FROM IMAGE VORTICES. CENTER VORTEX EFFECTS ARE OMITTED.
C
      CALL VVELS(NV,CPY,CPZ,VX,VY,G,RB,V,W,VRTMAX)
      WRITE(6,32) J11,CPX,CPY,CPZ,V,W
      IF (NVLOUT.EQ.0) GO TO 69
      IC=J11
      WRITE (7,746) IC,CPX,CPY,CPZ,V,W
   69 CONTINUE
      GO TO 99
    2 STOP
      END



      SUBROUTINE CRUCI(NC,D,X,Y,VS,WS)
C
C     VERSION: VPATH2
C
C
C   USING (X,Y) AS COORDINATES IN THE CROSS FLOW PLANE.
C   THIS SUBROUTINE COMPUTES THE CROSSFLOW VELOCITY COMPONENTS AT A POIN
C   (X,Y) DUE TO THE DEFLECTION OF A SINGLE FIN IN A WING - BODY COMBINA
C   THE ANGLE OF DEFLECTION IS D RADIANS AND THE FIN THAT IS DEFLECTED I
C   IDENTIFIED BY THE CODE NC.  IF NC=1 THE RIGHT HORIZONTAL FIN IS DEFL
C   IF NC=2 ETC. WE COUNT COUNTERCLOCKWISE. . NUMERICAL INTEGRATION IS U
C   DETERMINE THE VELOCITIES . THE ACCURACY OF INTEGRATION IS DETERMINED
C   THE TOLERANCE TOL - IN THE DATA STATEMENT. A POINT NEAR THE BODY RE
C   MANY INTEGRATION POINTS. THE SCHEME IS SINGULAR ON THE BODY.
C
      COMMON/BLK1/A,R,S,PI,CI
      COMMON AA,SIG,SS,GAM
      EXTERNAL FCT
      COMPLEX CI,TAU,TT,TPA,SIG,SS,EGP,EGM,T1,VEL,T2,DSDT,TP2,TM2,TP4,
     1FCT,   T21,T22,SIMP,T20
      DATA TOL/.02/
      SCA=R
      X=X/SCA
      Y=Y/SCA
      A=A/SCA
      AA=A*A
      GAM=.5*ACOS(AA)
      GAM1=.9*GAM
C
C   TRANSFORM X,Y TO PROPER QUADRANT
C
      TH=FLOAT(NC-1)*PI/2.
      XS=X*COS(TH)+Y*SIN(TH)
      YS=Y*COS(TH)-X*SIN(TH)
      TAU=CMPLX(XS,ABS(YS))
      TT=TAU*TAU
```

```
      TPA=TT+AA*AA/TT
      TM2=TPA-2.
      TP2=TPA+2.
      IF(AIMAG(TM2).GE.0.)TM2= CSQRT(TM2)
      IF(AIMAG(TM2).LT.0.)TM2=-CSQRT(TM2)
      IF(AIMAG(TP2).GE.0.)TP2= CSQRT(TP2)
      IF(AIMAG(TP2).LT.0.)TP2=-CSQRT(TP2)
      TP4=TP2*TM2
      SIG=.5*(TM2+TP2)
      SS=SIG*SIG
      EGP=CEXP(CI*GAM)
      EGM=1./EGP
      T1=A*(1./(SIG-EGP)-1./(SIG-EGM))
      NG=10
      T20=CMPLX(0.,0.)
   22 T21=SIMP(0.,GAM1,NG,FCT)
      IF(CABS(T21-T20)/CABS(T21).LT.TOL)GO TO 21
      IF(NG.GT.3000)WRITE(6,5)
      IF(NG.GT.3000)GO TO 21
    5 FORMAT(//* SORRY DOES NOT CONVERGE IN CRUCT *//)
      NG=NG*2
      T20=T21
      GO TO 22
   21 T20=CMPLX(0.,0.)
      NG=20
   33 T22=SIMP(GAM1,GAM,NG,FCT)
      IF(CABS(T22-T20)/CABS(T22).LT.TOL)GO TO 31
      IF(NG.GT.3000)WRITE(6,5)
      IF(NG.GT.3000)GO TO 31
      NG=NG*2
      T20=T22
      GO TO 33
   31 CONTINUE
      T2=T21+T22
      DSDT=.5*(TAU-AA*AA/(TT*TAU)) *(TP2+TM2)/TP4
      VEL=Q*DSDT*(T1-CI*T2/SQRT(2.))/PI
      V=REAL(VEL)
      W=-AIMAG(VEL)
      IF(YS.LT.0.)V=-V
C
C      ROTATE VELOCITIES BACK
C
      VS=V*COS(TH)-W*SIN(TH)
      WS=V*SIN(TH)+W*COS(TH)
      A=A*SCA
      X=X*SCA
      Y=Y*SCA
      RETURN
      END


      SUBROUTINE DASCRU (A,B,H,N,X0,WK,IER,ES,VRTMAX)
C
C     VERSION: VPATH2
C
C     THIS SUBROUTINE PERFORMS INTEGRATION
C
C                                       ES SHOULD BE SET TO .5 TIMES THE
C                                       DESIRED RELATIVE PRECISION OF
C
```

```
C                                      THE SOLUTION
C
      DIMENSION            WK(1),X0(1)
C
      INTEGER              SW
C
      LOGICAL              BE,BH,BR,BX
C
      DATA                 ZERO,P5,OP5,THREE,FOUR/0.,.5,1.5,3.,4./
C
      IER = 0
      IF(A - B) 4,100,4
    4 IB1=N+N
      IB2=IB1+N
      HMIN=0.01*ABS(H)
      BH=.TRUE.
      BR=.TRUE.
      BX=.TRUE.
C
C                                      CHECK FOR THE PROPER SIGN OF H
C
      H=SIGN(ABS(H),B-A)
      X=A
    5 XS=X
      DO 10  J=1,N
         IJK0=N+J
         WK(IJK0)=X0(J)
   10 CONTINUE
   15 HS=H
      Q=X+H-B
      BE=.TRUE.
      IF(.NOT.((H.GT.ZERO.AND.Q.GE.ZERO).OR.(H.LT.ZERO.AND.Q.LE.ZERO)))
     1   GO TO 20
      H=B-X
      BR=.FALSE.
   20 H3=H/THREE
C
C                                      CALCULATE SOLN. AT X+H
C    NOTE: ARRAY WK CONTAINS V FOR ODD INDEX,W FOR EVEN INDEX.
C
C
      DO 90  SW=1,5
         CALL F(X0,X,N,WK,VRTMAX)
         DO 70  I=1,N
            Q=HS*WK(I)
            IJK0=N+I
            IJK1=IB1+I
            IJK2=IB2+I
            GO TO (25,30,35,40,45),SW
   25       R=Q
            WK(IJK1)=Q
            GO TO 50
   30       R=P5*(Q+WK(IJK1))
            GO TO 50
   35       R=THREE*Q
            WK(IJK2)=R
            R=.375*(R+WK(IJK1))
            GO TO 50
   40       R=WK(IJK1)+FOUR*Q
            WK(IJK1)=R
            R=OP5*(R-WK(IJK2))
            GO TO 50
   45       R=P5*(Q+WK(IJK1))
```

```
            Q= ABS(H*R - OP5*(Q+HK(IJK2)))
   50       X0(I)=HK(IJK3)+Q
            IF(SN.NE.5) GO TO 70
C
C                                        AUTOMATIC STEP CHANGE
C
            E=ABS(X0(I))
            R=E5
            IF(E.GE.1.E-3) R=E*E5
C
C                                        TEST ADJUSTMENT OF THE STEP
C
            IF(Q.LT.R .OR.(.NOT. BX)) GO TO 65
            BR=.TRUE.
            BH=.FALSE.
            H=P5*H
            IF(ABS(H).GE.HMIN) GO TO 55
C
C                                        THE STEP IS HALVED RESTORE X AND X0,
C                                        AND GO BACK FOR REPEATED INTEGRATION
C                                        WITH THIS NEW STEP
C
            H=SIGN(1.,H)*HMIN
            BX=.FALSE.
   55       DO 60  J=1,N
               IJK0=N+J
               X0(J)=HK(IJK0)
   60       CONTINUE
            X=XS
            GO TO 15
   65       IF(Q.GE.0.03125*R) BE=.FALSE.
   70    CONTINUE
         GO TO (75,90,80,85,90),SN
   75    X=X+H3
         GO TO 90
   80    X=X+P5*H3
         GO TO 90
   85    X=X+P5*H
   90 CONTINUE
C
C                                        TEST A POSSIBLE DOUBLING OF THE STEP
C
      IF(.NOT.(BE.AND.BH.AND.BR)) GO TO 95
      H=H+H
      BX=.TRUE.
   95 BH=.TRUE.
      IF(BR) GO TO 5
      H=H9
      IF(BX .OR. HE) GO TO 9005
      IER = 33
      GO TO 9005
  100 DO 105 I=1,N
         X0(I)=ZERO
  105 CONTINUE
 9005 RETURN
      END
```

```
      SUBROUTINE F(XO,PX,M,WK,VRTMAX)
C
C     VERSION: VPATH2
C
C     THIS SUBROUTINE IS CALLED BY PASCRU TO CALCULATE CROSS FLOW
C     PLANE VELOCITIES
C
      COMPLEX CI,Z,FCT,SIMP
      COMMON/VEL/AL,BE,D1,D2,D3,D4,VX(30),VY(30),G(30),NV,NDEL,NS,NF,
     1XE(7),YE(7),YF(7),C(7,7),IFIN
      COMMON/BLK1/A,R,S,PI,CI
      COMMON/BLK2/AC,PHI
      COMMON/FINLE/XLE(80),CGLOC(80),GAMLE(80),MSWR,MSWL,MSWU,MSWD,
     1 NEDGV,XTIPLE
      COMMON/SIDEDG/XSE(80),CGSELC(80),GAMSE(80),NSW,NSIDGE,XTIPTE
C
      DIMENSION XO(1),WK(1),V(30),W(30),VV(30),WW(30),NCC(4)
C
      EXTERNAL Z,FCT,SIMP
      CI=CMPLX(0.,1.)
      PI=3.14159265
      DO 888 I=1,NV
      J=2*I-1
      K=J+1
      VX(I)=XO(J)
  888 VY(I)=XO(K)
      CALL SHAPE(PX,A,S)
C
C  NOTE: COORDINATE VX(I) IS THE Y-COORDINATE IN THE CROSS FLOW PLANE.
C        COORDINATE VY(I) IS THE Z-COORDINATE IN THE CROSS FLOW PLANE.
C
C  .. COMPUTE VELOCITIES IN THE CROSSFLOW PLANE ...
C     V(I) IS IN THE Y-DIRECTION.
C     W(I) IS IN THE Z-DIRECTION.
C
C
      R=SQRT(.5*(S*S+A**4/(S*S)))
      DO 31 J=1,4
   31 NCC(J)=0
      IF(D1.NE.0.)NCC(1)=1
      IF(D2.NE.0.)NCC(2)=1
      IF(D3.NE.0.)NCC(3)=1
      IF(D4.NE.0.)NCC(4)=1
      MH=NCC(2)+NCC(4)
      MV=NCC(1)+NCC(3)
      DO 100 I=1,NV
      X=VX(I)
      Y=VY(I)
      VS=0.
      WS=0.
      IF(AL.NE.0.)CALL PITROL(AL,X,Y,VS,WS)
      V(I)=VS
      W(I)=WS
      IF(BE.EQ.0.)GO TO 17
      CALL PITROL(BE,Y,-X,VS,WS)
      V(I)=V(I)-WS
      W(I)=W(I)+VS
   17 CONTINUE
      IF(NDEL.EQ.0.OR.IFIN.EQ.0)GO TO 66
      IF(MH.EQ.0)GO TO 6
      IF(MH.EQ.1)GO TO 5
      CALL SYMFIN(1,D4,X,Y,VS,WS)
      V(I)=V(I)+VS
```

```
      W(I)=W(I)+WS
    5 CONTINUE
      IF(MH.EQ.2)GO TO 8
      IF(NCC(2).EQ.1)NC=1
      IF(NCC(4).EQ.1)NC=3
      IF(NCC(2).EQ.1)DD=D2
      IF(NCC(4).EQ.1)DD=-D4
      CALL CRUCI(NC,DD,X,Y,VS,WS)
      V(I)=V(I)+VS
      W(I)=W(I)+WS
      GO TO 6
    8 DD=D2-D4
      CALL CRUCI(1,DD,X,Y,VS,WS)
      V(I)=V(I)+VS
      W(I)=W(I)+WS
    6 CONTINUE
      IF(MV.EQ.0)GO TO 66
      IF(MV.EQ.1)GO TO 55
      CALL SYMFIN(2,D3,X,Y,VS,WS)
      V(I)=V(I)+VS
      W(I)=W(I)+WS
   55 CONTINUE
      IF(MV.EQ.2)GO TO 88
      IF(NCC(1).EQ.1)NC=2
      IF(NCC(3).EQ.1)NC=4
      IF(NCC(1).EQ.1)DD=D1
      IF(NCC(3).EQ.1)DD=-D3
      CALL CRUCI(NC,DD,X,Y,VS,WS)
      V(I)=V(I)+VS
      W(I)=W(I)+WS
      GO TO 66
   88 DD=D1-D3
      CALL CRUCI(2,DD,X,Y,VS,WS)
      V(I)=V(I)+VS
      W(I)=W(I)+WS
   66 CONTINUE
C
C     IF FIN LE   VORTICITY IS INCLUDED,DETERMINE BY INTERPOLATION THE
C     EFFECTS OF THE SPECIFIED VORTICITY.
C
C NOTE: HERE IFIN=1....RIGHT FIN
C                 2....LEFT FIN
C                 3....UPPER FIN
C                 4....LOWER FIN.
C
      IF (NEDGV.EQ.0) GO TO 20
      IFIN=1
      KSTART=1
      KUL=MSWR
   23 CONTINUE
      IF (IFIN.EQ.5) GO TO 20
      IF (IFIN.EQ.2) KSTART=MSWR+1
      IF (IFIN.EQ.3) KSTART=MSWR+MSWL+1
      IF (IFIN.EQ.4) KSTART=MSWR+MSWL+MSWU+1
      DO 21 IFV=KSTART,KUL
      IF (PX.LT.XLE(KSTART)) GO TO 20
      JV=IFV-1
      IF (IFV.EQ.1) JV=1
      IF (PX.LE.XLE(IFV)) GO TO 22
   21 CONTINUE
      IF (PX.LE.XTIPLE) GO TO 38
      GO TO 20
   22 KV=JV+1
```

```
      X1=XLE(JV)
      X2=XLE(KV)
      WT1=(X2-PX)/(X2-X1)
      WT2=(PX-X1)/(X2-X1)
      IF (IFIN.EQ.3.OR.IFIN.EQ.4) GO TO 24
      YVINT=WT1*CGLOC(JV)+WT2*CGLOC(KV)
      ZVBAR=(PX-XF(1))*TAN(AL/2.0)
      GAMINT=WT1*GAMLE (JV)+WT2*GAMLE (KV)
      GO TO 39
   38 GAMINT=GAMLE(KUL)
      IF (IFIN.EQ.3.OR.IFIN.EQ.4) GO TO 40
      YVINT=CGLOC(KUL)
      ZVBAR=(PX-XF(1))*TAN(AL/2.0)
      GO TO 39
   40 ZVINT=CGLOC(KUL)
      YVBAR=-(PX-XF(1))*TAN(BE/2.0)
      GO TO 41
   39 CALL VVELS(1,X,Y,YVINT,ZVBAR,GAMINT,A,VS,WS,VRTMAX)
      GO TO 25
   24 ZVINT=WT1*CGLOC(JV)+WT2*CGLOC(KV)
      YVBAR=-(PX-XF(1))*TAN(BE/2.0)
      GAMINT=WT1*GAMLE (JV)+WT2*GAMLE (KV)
   41 CALL VVELS (1,X,Y,YVBAR,ZVINT,GAMINT,A,V,W,VRTMAX)
   25 V(I)=V(I)+VS
      W(I)=W(I)+WS
      IFIN=IFIN+1
      IF (IFIN.EQ.2) KUL=MSWR+MSWL
      IF (IFIN.EQ.3) KUL=MSWR+MSWL+MSWU
      IF (IFIN.EQ.4) KUL=MSWR+MSWL+MSWU+MSWD
      GO TO 23
   20 CONTINUE
C
C
C     IF FIN SE VORTICITY IS INCLUDED,DETERMINE BY INTERPOLATION THE
C     EFFECTS OF THE SPECIFIED VORTICITY.
C
      IF (NSIDGE.EQ.0) GO TO 28
      IFIN=1
      KSTART=1
      KUL=NCW
   27 CONTINUE
      IF (IFIN.EQ.5) GO TO 28
      IF (IFIN.EQ.2) KSTART=NCW+1
      IF (IFIN.EQ.3) KSTART=2*NCW+1
      IF (IFIN.EQ.4) KSTART=3*NCW+1
      DO 29 JSE=KSTART,KUL
      IF (PX.LT.XSE(KSTART)) GO TO 28
      JVSE=JSE-1
      IF (JSE.EQ.1) JVSE=1
      IF (PX.LE.XSE(JSE)) GO TO 30
   29 CONTINUE
      IF (PX.LE.XTIPSE) GO TO 51
      GO TO 28
   30 KVSE=JVSE+1
      X1=XSE(JVSE)
      X2=XSE(KVSE)
      WT1=(X2-PX)/(X2-X1)
      WT2=(PX-X1)/(X2-X1)
      IF (IFIN.EQ.3.OR.IFIN.EQ.4) GO TO 32
      YVINT=WT1*CGSELC(JVSE)+WT2*CGSELC(KVSE)
      ZVBAR=(PX-XF(1))*TAN(AL/2.0)
      GAMINT=WT1*GAMSE(JVSE)+WT2*GAMSE(KVSE)
      GO TO 59
```

```
   51 GAMINT=GAMSE(KUL)
      IF (IFIN.EQ.3.OR.IFIN.EQ.4) GO TO 52
      YVINT=CGSELC(KUL)
      ZVBAR=(PX-XF(1))*TAN(AL/2.0)
      GO TO 59
   52 ZVINT=CGSELC(KUL)
      YVBAR=-(PX-XF(1))*TAN(BE/2.0)
      GO TO 53
   59 CALL VVELS (1,X,Y,YVINT,ZVBAR,GAMINT,A,VS,WS,VRTMAX)
      GO TO 35
   32 ZVINT=WT1*CGSELC(JVSE)+WT2*CGSELC(KVSE)
      YVBAR=-(PX-XF(1))*TAN(BE/2.0)
      GAMINT=WT1*GAMSE(JVSE)+WT2*GAMSE(KVSE)
   53 CALL VVELS(1,X,Y,YVBAR,ZVINT,GAMINT,A,VS,WS,VRTMAX)
   35 V(I)=V(I)+VS
      W(I)=W(I)+WS
      IFIN=IFIN+1
      IF (IFIN.EQ.2) KUL=2*NCW
      IF (IFIN.EQ.3) KUL=3*NCW
      IF (IFIN.EQ.4) KUL=4*NCW
      GO TO 27
   28 CONTINUE
  100 CONTINUE
      CALL VOTEX(NV,VX,VY,G,VV,WW)
      CAL=COS(AC)
      DO 101 I=1,NV
      V(I)=V(I)+VV(I)
      W(I)=W(I)+WW(I)
      J=2*I-1
      K=J+1
      AK(J)=V(I)/CAL
      AK(K)=W(I)/CAL
  101 CONTINUE
      RETURN
      END
```

```
      COMPLEX FUNCTION FCT(T)
C
C     VERSION: VPATH2
C
C     FCT IS THE INTEGRAND OF THE INTEGRAL ASOCIATED WITH VELOCITY
C     COMPONENTS FOR THE SINGLY DEFLECTED FIN CASE
C
      COMPLEX SIG,SS
      COMMON AA,SIG,SS,GAM
      TE=COS(2.*T)-AA
      IF(T.GE.GAM)TE=0.
      FCT=2.*(SQRT(TE   )+SQRT(COS(2.*T)+AA  ))*((SS+1.)*COS(T)
     1-2.*SIG)/((SS-2.*SIG*COS(T)+1.)*(SS-2.*SIG*COS(T)+1.))
       RETURN
      END
```

```
      SUBROUTINE PITROL(AL,X,Y,VS,WS)
C
C     VERSION: VPATH2
C
C   THIS SUBROUTINE COMPUTES THE CROSSFLOW VELOCITY COMPONENTS FOR A CRU
C   WING BODY COMBINATION AT ANGLE OF ATTACK AL, AND SIDESLIP ANGLE BE
C
      COMMON/BLK1/A,R,S,PI,CI
      COMPLEX Z,CI,ZA,SQ,SQS,VELAL
      AA=A*A
      Z=CMPLX(X,Y)
      ZA=Z+AA/Z
      SA=S+AA/S
      SQ=ZA*ZA-SA*SA
      AY=1.0
      IF(AIMAG(ZA).LT.0.0) AY=-1.0
      AYZ=1.0
      IF(AIMAG(SQ).LT.0.0) AYZ=-1.0
      SQS=CSQRT(SQ)*AY*AYZ
      IF((ABS(AIMAG(ZA)).LE.0.0).AND.(REAL(ZA).LT.0.0))SQS=CMPLX(-REAL(S
     1QS),AIMAG(SQS))
      VELAL=-CI*SIN(AL)*(1.-AA/Z**2)*ZA/SQS
C
C     VS....SIDEWASH INCLUDING FREE STREAM COMPONENT
C     WS....UPWASH INCLUDING FREE STREAM COMPONENT
C
      VS=REAL(VELAL)
      WS=-AIMAG(VELAL)
      RETURN
      END
```

```
      SUBROUTINE PLOTVB(X,Y,Z,NP,NIP1,NVN,NDP,ROT,XF,YF,NF,X2,Y2)
C
C     VERSION: VPATH2
C
C  ROUTINE TO GENERATE A PLOT VORTEX LOCATION RELATIVE TO
C  THE WING-BODY CONFIGURATION
C  DEFINITIONS:
C    NC   = INDEX OF CURVE
C    NIP1 = NO. OF BODY STATIONS
C    NVN  = NO. OF VORTICES
C    NF   = NO. OF WING DEFINITION CARDS
C
      DIMENSION X(NDP,52),Y(NDP,52),Z(NDP,52)
      DIMENSION NP(52),ROT(3),XCG(3),XF(7),YF(7)
      DIMENSION X2(17,18),Y2(17,18),NP2(18),SYMBOL(40)
C
      DATA LWID,LENG,XCG/ 100,50, 0.,0.,0./
      DATA SYMBOL / 1H*,1H+,1H-,1H.,1H0,1H1,1H2,1H3,1H4,1H5,1H6,
     *  1H7,1H8,1H9,1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK,1HL,
     *  1HM,1HN,1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ/
      WRITE(6,10)
      WRITE(6,11)
 10   FORMAT(1H1)
 11   FORMAT(1H0)
C
C  FIND MAXIMUM DIAMETER
C
```

```
      BMAX=0.
      DO 100 I=1,NIP1
  100 BMAX=AMAX1(BMAX,Y(1,I+1),Z(1,I+1))
C
C  CURVE 1:  DRAW AXES
C
      NC=1
      DO 120 I=1,6
      X(I,1)=X(1,1)
      Y(I,1)=0.
  120 Z(I,1)=0.
      X(2,1)=X(1,NIP1+1)
      Y(4,1)=1.5*BMAX
      Z(6,1)=1.5*BMAX
      NP(1)=6
C
C  CURVES:  2 TO NIP1+1
C  GENERATE CROSS SECTIONS
C
      NGV=NIP1+NVN+3
      MERID=17
      DO 160 J=1,NIP1
      NC=NC+1
      B1  =X(1,NC)
      RLOC=Y(1,NC)
      BLOC=Z(1,NC)
      SLOC=Y(2,NC)
C         SAVE RLOC AND BLOC
      Y(J,NGV)=RLOC
      Z(J,NGV+1)=BLOC
      Y(J,NGV+2)=SLOC
C
C  GENERATE BODY CROSS SECTION
C
      DTH=2.*3.1415926/(MERID-1)
      DO 140 I=1,MERID
      PHI=(I-1)*DTH
      RAD=(COS(PHI)/BLOC)**2+(SIN(PHI)/RLOC)**2
      RAD=SQRT(1./RAD)
      Y(I,NC)=RAD*SIN(PHI)
      Z(I,NC)=RAD*COS(PHI)
      X(I,NC)=B1
  140 CONTINUE
  160 NP(NC)=MERID
C
C  PLOT VORTEX LOCATION (ALREADY DEFINED)
C
      DO 170 I=1,NVN
      NC=NC+1
  170 NP(NC)=NIP1
C
C  WING OUTLINE
C
      IF (NF.LE.0) GO TO 200
      DO 190 J=1,2
      NC=NC+1
      SGN=(-1)**(J+1)
      DO 180 I=1,NF
      X(I,NC)=XF(I)
      Y(I,NC)=YF(I)*SGN
      Z(I,NC)=0.0
  180 CONTINUE
      NF1=NF+1
```

```
      X(NF1,NC)=XF(1)
      Y(NF1,NC)=YF(1)*SGN
      Z(NF1,NC)=0.0
      NP(NC)=NF1
190   CONTINUE
200   CONTINUE
C
C  PLOT CROSS SECTIONS WITH VORTEX LOCATIONS  --------------------------
C
      DO 240 ISECTN=1,3
      IF (ISECTN.EQ.1) JSECTN=1
      IF (ISECTN.EQ.2) JSECTN=NIP1/2
      IF (ISECTN.EQ.3) JSECTN=NIP1
C
C  COPY BODY
C
      DO 220 I=1,MERID
      X2(I,1)=Y(I,JSECTN+1)
      Y2(I,1)=Z(I,JSECTN+1)
220   CONTINUE
      NP2(1)=MERID
      NC2=1
C
C  WING OUTER BOUNDARIES
C
      SLOC=Y(JSECTN,NGV+2)
      X2(1,2)=SLOC
      Y2(1,2)=0.
      X2(2,2)=-SLOC
      Y2(2,2)=0.
      NP2(2)=2
      NC2=NC2+1
C
C  COPY VORTICES AT JSECTN
C
      DO 230 J=1,NVN
      NC2=NC2+1
      JCV=NIP1+1+J
      X2(1,NC2)=Y(JSECTN,JCV)
      Y2(1,NC2)=Z(JSECTN,JCV)
      NP2(NC2)=1
230   CONTINUE
C
C  PLOT CROSS SECTIONS
C
      CALL PLOTA2(X2,Y2,3,NP2,17,NC2,LWID,LENG)
      WRITE(6,23) JSECTN,X(1,JSECTN+1)
      WRITE(6,24) (I,SYMBOL(I+2),I=1,NVN)
240   CONTINUE
C
C  PLOT PERSPECTIVE VIEWS  -------------------------------------------
C
C  TOP VIEW
      CALL PLOTA2(X,Y,3,NP,NDP,NC,LWID,LENG)
C     CALL PLOTV2(X,Y,3,NP,NDP,NC,LWID,LENG,LINE,NLIM)
      WRITE(6,20)
      NSYM=NVN
      JSYM=1+NIP1
      JN = JSYM+NVN
      IF (JN.GT.40) NSYM=JN-40
      WRITE(6,24) (I,SYMBOL(I+JSYM),I=1,NSYM)
      IF (JN.LE.40) GO TO 210
```

```
      JSYM=NSYM+1
      ISYM = NSYM
      WRITE(6,24) (I,SYMBOL(I+ISYM),I=JSYM,NVM)
  210 CONTINUE
C
C  SIDE VIEW
      CALL PLOTA2(X,Z,5,NP,NDP,NC,LAID,LENG)
C     CALL PLOTV2(X,Z,5,NP,NDP,NC,LAID,LENG,LINE,NLIN)
      WRITE(6,21)
C
C  PERSPECTIVE VIEW
      ROT(1) = 0.
      ROT(2)=30.
      ROT(3)=20.
      CALL PLOTA3(X,Y,Z,NP,NDP,NC,ROT,XCG,X,Y,3)
      CALL PLOTA2(X,Y,3,NP,NDP,NC,LAID,LENG)
C     CALL PLOTV2(X,Y,5,NP,NDP,NC,LAID,LENG,LINE,NLIN)
      WRITE(6,22) ROT
C
C
   20 FORMAT(/20X,22HTOP VIEW  - Y VERSUS X)
   21 FORMAT(/20X,22HSIDE VIEW - Z VERSUS X)
   22 FORMAT(/20X,15HPERSPECTIVE - ROT=,3F10.2)
   23 FORMAT(/20X,29HBODY CROSS SECTION  - JSECTN=,I3,
     *   5X,4HXIP=,F10.3)
   24 FORMAT(20X,14HVORTEX SYMBOLS,10(1X,I2,1H=,A1,1H,))
C
C
      RETURN
      END


      SUBROUTINE SHAPE(X,R,S)
C
C     VERSION: VPATH2
C
C  SUBROUTINE TO COMPUTE LOCAL BODY RADIUS AND FIN SPAN MEASURED FROM
C     THE BODY CENTERLINE
C
      COMMON/VEL/AL,BE,Q1,Q2,Q3,Q4,VX(30),VY(30),G(30),NV,NDEL,NS,NF,
     1XE(7),XF(7),YF(7),C(7,7),IFIN
      IFIN=0
      DO 1 K=1,NS
      XL=XE(K)
      J=K
      IF(X.LE.XL)GO TO 2
    1 CONTINUE
    2 R=C(J,1)+X*C(J,5)+X*X*C(J,6)
      ARG=X*X*C(J,2)+X*C(J,3)+C(J,4)
      R=R+SQRT(ARG)*C(J,7)
      S=R
      IF(NF.EQ.0)RETURN
      IF(X.LE.XF(1).OR.X.GT.XF(NF))RETURN
      IFIN=1
      DO 3 K=2,NF
      J=K
      XL=XF(K)
      IF(X.LE.XL)GO TO 4
    3 CONTINUE
    4 J1=J-1
      S=(X-XF(J1))*(YF(J)-YF(J1))/(XF(J)-XF(J1))+YF(J1)
      RETURN
      END
```

```
      COMPLEX FUNCTION SIMP(A,B,N,F)
C
C     VERSION: VPATH2
C
C     SIMP INTEGRATES THE INTEGRAL INVOLVING FCT AS SET UP IN CRUCI
C
      EXTERNAL F
      COMPLEX F,SUMEND,SUMID
      TWOH=(B-A)/N
      H=TWOH/2.
      SUMEND=CMPLX(0.,0.)
      SUMID=CMPLX(0.,0.)
      DO 1 K=1,N
      X=A+FLOAT(K-1)*TWOH
      SUMEND=SUMEND+F(X)
    1 SUMID=SUMID+F(X+H)
      SIMP=(2.*SUMEND+4.*SUMID-F(A)+F(B))*H/3.
      RETURN
      END
```

```
      SUBROUTINE SYMFIN(NC,D,X,Y,VS,WS)
C
C     VERSION: VPATH2
C
C   THIS SUBROUTINE COMPUTES THE CROSSFLOW VELOCITY COMPONENTS VS,WS
C   AT THE POINT X,Y, INDUCED BY  A SYMMETRIC DEFLECTION OF A PAIR OF FI
C   BY AN ANGLE D RADIANS IN A CRUCIFORM WING BODY COMBINATION .  THE CO
C   NC DETERMINES WHICH PAIR OF FINS ARE DEFLECTED. IF NC=1, HORIZONTAL
C   IF NC=2 IT IS THE VERTICAL PAIR  .
C
      COMMON/BLK1/A,R ,S,PI,CI
      COMPLEX CI,T,TT,TPA,SQ,CC,   T2,T3,T4,VEL,TMA,TI,CLT,ARG,TINV,CCS
      R0=.5*(S+A*A/S)
      XS=X
      YS=Y
C
C   IF THE VERTICAL FINS ARE DEFLECTED ROTATE (X,Y) BY PI/2
C
      IF(NC.NE.2)GO TO 1
      XS=Y
      YS=-X
    1 T=CMPLX(ABS(XS),ABS(YS))
      TT=T*T
      AA=A*A
      TPA=TT+AA
      R00=R0*R0
      SQ=TPA*TPA
      TMA=TT-AA
      CCS=SQ-4.*R00*TT
      SRT=SQRT(1.-AA/R00)
      IF(AIMAG(CCS).GE.0.)CC= CSQRT(CCS)
      IF(AIMAG(CCS).LT.0.)CC=-CSQRT(CCS)
C
C.... SECOND TERM
      TI=TPA*SRT/(A*CC/R0)
      ARG=(CI+TI)/(CI-TI)
      CLT=CLOG(ARG)
      TINV=CI*.5*CLT
      T2= (TMA/TT)*.5*CLT
```

```
C... THIRD TERM
      T3=-CI*PI*.5*TPA/TT
C .... FOURTH TERM
      T4=CI*TMA*TPA*(PI*.5+ACOS(A/R0))/(CC*TT)
C.... VELOCITY
      VEL=-G*( T2+T3+T4)/PI
      V=REAL(VEL)
      W=-AIMAG(VEL)
      IF(XS*YS.LT.0.)V=-V
      VS=V
      WS=W
      IF(MC.NE.2)RETURN
      VS=-W
      WS=V
      RETURN
      END
```

```
      SUBROUTINE VOTEX(NV,XV,YV,GV,VV,WW)
C
C     VERSION: VPATH2
C
C   THIS SUBROUTINE COMPUTES THE PERTURBATION VELOCITY COMPONENTS AT THE
C     VORTEX LOCATIONS ACCOUNTING FOR MUTUAL EFFECTS AND THE PRESENCE
C     OF A CRUCIFORM WING  BODY COMBINATION
C
      DIMENSION XV(30),YV(30),GV(30),VV(30),WW(30)
      DIMENSION VX(30),VY(30),G(30)
      COMMON/V/A4,R4
      COMMON/BLK1/A,R,S,PI,CI
      EXTERNAL Z
      COMPLEX CI,T0,Z,S0,T2,S2,T3,S3,T4,S4,TMA4,SMR4,DSDT,DTDS,D2SDT
     1,V1,V2,V3,VEL,TAU,S1,S0B,SIB
      NN=NV-1
      AA=A*A
      A4=AA*AA
      RR=R*R
      R4=RR*RR
      DO 100 I=1,NV
      X0=XV(I)
      Y0=YV(I)
      G0=GV(I)
      K1=0
      DO 99 J=1,NV
      IF(J.EQ.I)GO TO 99
      K1=K1+1
      VX(K1)=XV(J)
      VY(K1)=YV(J)
      G(K1)=GV(J)
   99 CONTINUE
      T0=CMPLX(X0,Y0)
      S0=Z(T0)
      S0B=CONJG(S0)
      T2=T0*T0
      T3=T0*T2
      T4=T2*T2
      S2=S0*S0
      S3=S2*S0
      S4=S2*S2
      TMA4=T4-A4
      SMR4=S4-R4
```

```
      DSDT=TMA4*S3/(T3*SMR4)
      DTDS=SMR4*T3/(S3*TMA4)
      D2SDT=S3*(T3+3.*A4)/(SMR4*T4)-S2*DSDT*TMA4*(S4+3.*R4)/
     1(T3*SMR4*SMR4)
      V1=-G0*DTDS*D2SDT/2.
      V2=G0*DSDT*S0B/(S0B*S0-RR)
      V3=CMPLX(0.,0.)
      DO 3 K=1,NN
      TAU=CMPLX(VX(K),VY(K))
      SI=Z(TAU)
      SIB=CONJG(SI)
    3 V3=V3-G(K)*(1./(S0-SI)-SIB/(S0*SIB-RR))*DSDT
      VEL=CI*(V1+V2+V3)/(PI+PI)
      VV(I)=REAL(VEL)
      WW(I)=-AIMAG(VEL)
  100 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE VVELS(NV,YY,ZZ,VX,VY,G,RB,V,W,VRTMAX)
C
C     VERSION: VPATH2.
C
C     THIS SUBROUTINE COMPUTES PERTURBATION VELOCITY COMPONENTS DUE TO
C     NV EXTERNAL VORTICES AND THEIR IMAGES INSIDE A BODY WITH CIRCULAR
C     CROSS SECTION.
C     CENTER VORTEX EFFECTS ARE NOT ACCOUNTED FOR.
C
      DIMENSION VX(1),VY(1),G(1)
C
      TLC=0.000001
      PI=3.1415926
      V=0.
      W=0.
      Y=YY/RB
      Z=ZZ/RB
      DO 1 I=1,NV
      GG=G(I)/(2.*PI*RB)
      XV=VX(I)/RB
      YV=VY(I)/RB
      ZVS=XV*XV+YV*YV
      DY=Y-XV
      DZ=Z-YV
      DYS=DY*DY
      DZS=DZ*DZ
      DEN1=DYS+DZS
      IF(DEN1.LE.TLC)GO TO 2
      V=V-GG*DZ/DEN1
      W=W+GG*DY/DEN1
    2 DEN2=(Y-XV/ZVS)**2+(Z-YV/ZVS)**2
      IF(ABS(DEN2).LE.TLC) GO TO 3
      V=V+GG*(Z-YV/ZVS)/DEN2
      W=W-GG*(Y-XV/ZVS)/DEN2
    3 CONTINUE
C
C     LIMIT MAGNITUDE OF PERTURBATION VELOCITIES TO VRTMAX.
C
    1 CONTINUE
      IF (V.GT.0.0.AND.ABS(V).GE.VRTMAX) V=VRTMAX
```

```
      IF (V.LT.0.0.AND.ABS(V).GE.VRTMAX) V=-VRTMAX
      IF (W.GT.0.0.AND.ABS(W).GE.VRTMAX) W=VRTMAX
      IF (W.LT.0.0.AND.ABS(W).GE.VRTMAX) W=-VRTMAX
      RETURN
      END



      COMPLEX FUNCTION Z(CT)
C
C     VERSION: VPATH2
C
C     THIS FUNCTION ROUTINE CALCULATES THE SIGMA VALUE IN THE
C     TRANSFORMED (CIRCLE) PLANE FOR GIVEN TAU IN THE PHYSICAL PLANE
C     TAU=X+IY
C
      COMMON/V/A4,R4
      COMPLEX T,TT,TPA,STP,SI,TPA2,SSI,SSTP,CT
      RT=ABS(REAL(CT))
      RI=ABS(AIMAG(CT))
      IR=0
      II=0
      IF(RT.NE.0.)IR=REAL(CT)/RT
      IF(RI.NE.0.)II=AIMAG(CT)/RI
      T=CMPLX(RT,RI)
      TT=T*T
      TPA=TT+A4/TT
      TPA2=TPA*TPA
      STP=TPA2-4.*R4
      AY=1.0
      IF(AIMAG(TPA).LT.0.0) AY=-1.0
      AYZ=1.0
      IF(AIMAG(STP).LT.0.0) AYZ=-1.0
      SSTP=CSQRT(STP)*AY*AYZ
      IF((ABS(AIMAG(TPA)).LE.0.0).AND.(REAL(TPA).LT.0.0))
     1      SSTP=CMPLX(-REAL(SSTP),AIMAG(SSTP))
      SSI=.5*(TPA+SSTP)
      SI=CSQRT(SSI)
      Z=CMPLX(IR*ABS(REAL(SI)),II*ABS(AIMAG(SI)))
      RETURN
      END
```

PROGRAM VPATHL

PROGRAM VPATHL

```
      PROGRAM VPATHL(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE4,TAPE7)
C
C          THIS PROGRAM COMPUTES THE PATHS AND VORTEX INDUCED CROSSFLOW
C     VELOCITIES AT SPECIFIED FIELD POINTS FOR A SET OF VORTICES IN THE
C     PRESENCE OF A WING-BODY COMBINATION AT ANGLE OF ATTACK AND ROLL.
C       SLENDER BODY THEORY IS USED IN THE COMPUTATION OF THE CROSSFLOW
C       VELOCITIES.  THE BODY IS ASSUMED TO HAVE ELLIPTICAL CROSS SECTION.
C
C
C   THE COORDINATE SYSTEM USED HERE IS THE BODY COORDINATE SYSTEM
C   WITH THE X-AXIS ALONG THE BODY CENTER-LINE STARTING AT THE NOSE TIP,
C       Y-AXIS TO THE RIGHT WHEN LOOKING FORWARD,Z-AXIS UP.
C
C
C   *********NOTE: WINGS ONLY - NO VERTICAL SURFACES*******************
C
C
      DIMENSION TITLE(20),XO(60),XIP(50),NK(120)
      DIMENSION VXP(30,30,2),NVV(30)
C
      COMMON/VEL/AL,BE,           VX(30),VY(30),G(30),NV,      NS,NF,
     1XE(7),XF(7),YF(7),C(7,7),IFIN
      COMMON/BLK2/AC,PHI
      COMMON/FINLE/XLE(80),CGLOC(80),GAMLE(80),MSWR,MSWL,MSWU,MSWD,
     1 NEDGV,XTIPLE
      COMMON/STDEDG/XSE(80),CGSELC(80),GAMSE(80),NCV,NSIDGE,XTIPTE
      COMMON/COMB/BFACT
      COMMON XPLT(30,52),YPLT(30,52),ZPLT(30,52),NPLT(52),ROT(5)
     *  ,XP2(17,18),YP2(17,18)
      COMMON /BSCALE/ XMAX,XMIN,YMAX,YMIN
      COMMON/PARAM/NOUT
C
      NAMELIST/DEBUG/NS,NF,NIP,NCPIN,NVLOUT,NOUT,VRTMAX,XE,C,XF,YF,NVV
C
    1 FORMAT(20A4)
    4 FORMAT(HI10)
    5 FORMAT(7F10.5)
    6 FORMAT(8F10.5)
    7 FORMAT(6F10.5)
    9 FORMAT(/5X,34HLOCAL BODY HORIZONTAL SEMI-AXIS = ,F10.5/5X,
     1              34HLOCAL BODY VERTICAL SEMI-AXIS   = ,F10.5/5X,
     2              34HLOCAL SEMI SPAN S               = ,F10.5/)
   11 FORMAT (//5X,33H INCLUDED ANGLE OF ATTACK(DEG) = ,F10.5,
     1 24H       ROLL ANGLE(DEG)  = ,F10.5/)
   21 FORMAT(//19H        X-STATION NO.,I3,9H        X=,F6.3,6X,
     1 25H INTEGRATION STEP SIZE = ,F10.5//)
   22 FORMAT(I15,4X,2E17.5,E15.5)
   25 FORMAT (////10X,36HVORTEX COORDINATES IN CROSS-FLOW PLANE,//)
   26 FORMAT (//43H              INITIAL VORTEX POSITIONS AT    X = ,F6.3/)
   27 FORMAT (10X,7H VORTEX,10X,7H Y,VRTX,10X,7H Z,VRTX,6X,
     1   10HGAMMA/VINF/)
   30 FORMAT(16I5)
   31 FORMAT(/// 6X,76HCROSSFLOW VELOCITIES AT CONTROL POINTS INDUCED BY
     1 VORTICES AND THEIR IMAGES.,//
     1 6X,2HIC,10X,6HX,BODY,10X,6HY,BODY,10X,6HZ,BODY,10X,1HV,15X,1HW)
   32 FORMAT(5X,I3,6X,5E15.5)
   60 FORMAT(3F10.5)
  700 FORMAT (//5(1H*), 59HPERMISSIBLE RELATIVE ERROR,E5,USED IN INTEGRA
     1TION SCHEME = ,F12.5/)
  701 FORMAT (////5(1H*),61HSUBROUTINE DASCRU CAN NOT OBTAIN VALUE FOR I
     1NTEGRATION STEP H,5(1H*)////)
  702 FORMAT (85X,I3,2F10.5)
  703 FORMAT (//85X,31HINTERPOLATED VORTEX COORDINATES/87X,1HI,5X,
```

```
     1   2HYV,10X,2HZV/)
  700 FORMAT (////17X,12HFIN GEOMETRY/10X,12HFIN SEMISPAN,11X,1H=,1X,
     A F10.5/
     1        10X,25HFIN ROOTCHORD              = ,F10.5/
     8        10X,25HFIN ROOT L.E. X-STATION= ,F10.5/
     2        10X,25H         L.E. Y-STATION= ,F10.5/
     3        10X,25HFIN TIP L.E. X-STATION = ,F10.5/
     4        10X,25H        L.E. Y-STATION = ,F10.5/
     5        10X,25HFIN TIP T.E. X-STATION = ,F10.5/
     6        10X,25H        T.E. Y-STATION = ,F10.5/
     8        10X,25HFIN ROOT T.E. X-STATION= ,F10.5/
     9        10X,25H         T.E. Y-STATION= ,F10.5,////)
  705 FORMAT (6X,I2,2X,F10.5,1X,F10.5,1X,F10.5)
  706 FORMAT (////10X,26HFIN LEADING EDGE VORTICITY/
     1 5X,3HJLE,6X,1HX,7X,10HY OR Z BAR,2X,11HGAMMA/VINF,/)
  707 FORMAT (////10X,25HFIN SIDE EDGE VORTICITY/5X,3HJSE,6X,1HX,7X,
     1    10HY OR Z BAR,2X,11HGAMMA/VINF,/)
  745 FORMAT (I5,3E12.5)
  746 FORMAT (I5,5E12.5)
C
C
C
      RAD=3.1415926/180.
C
C
C        .........  INPUT  ...........
C
   99 READ(5,1)TITLE
      IF(EOF(5))2,3
    3 CONTINUE
C
C  .. GEOMETRY ..
C
C
C          NS=NO. OF BODY SECTIONS WITH DIFFERENT GEOMETRY
C          NF= NO. OF CORNER POINTS USED TO DESCRIBE RIGHT WING PANEL.
C          NIP= NO. OF X= STATIONS PRINTED IN OUTPUT
C      NCPIN,NVLOUT GOVERN READING FROM AND WRITING ON DATA SETS.
C      NOUT=1 GIVES ADDITIONAL OUTPUT
C      IPLT =0 .....NO PLOTS IN PRINTED OUTPUT
C            1 .....READ IN MAX. AND MIN. X*S AND Y*S
C            5 .....PLOTS WILL BE SIZED AUTOMATICALLY
C
C          XE= X VALUES AT THE END OF EACH BODY SECTION
C          C= COEFFICIENTS IN THE BODY GEOMETRY EQUATION
C
C          XF,YF= X AND Y COODS OF THE WING BREAK IN SWEEP POINTS.
C
C          RFACT=VERTICAL AXIS/HORIZONTAL AXIS
C
      READ(5,4)NS,NF,NIP,NCPIN,NVLOUT,NOUT,IPLT
      READ(5,5) RFACT
      READ(5,5)(XE(I),I=1,NS)
      READ(5,5)((C(I,J),J=1,7),I=1,NS)
      IF(NF.NE.0) READ(5,6)(XF(I),YF(I),I=1,NF)
      IF (IPLT.EQ.1) READ (5,6) XMAX,XMIN,YMAX,YMIN
C
C
C      DETERMINE DISTANCE FROM BODY CENTERLINE TO WING TIP(=SEMISPAN)
C      AND X-LOCATIONS OF WING TIP LEADING EDGE AND TRAILING EDGE.
C
      IF (NF.EQ.0) GO TO 84
      YMAX=0
```

```
      CRP=SQRT((XF(NF)-XF(1))*(XF(NF)-XF(1))+(YF(NF)-YF(1))*(YF(NF)-
     1 YF(1)))
      DO 80 I=1,NF
      IF (YF(I).GT.YMAX) YMAX=YF(I)
   80 CONTINUE
      NFM1=NF-1
      DO 81 I=1,NFM1
      IP1=I+1
      IF (YF(I).EQ.YMAX.AND.YF(IP1).EQ.YMAX) GO TO 82
      IF (YF(I).EQ.YMAX) GO TO 83
   81 CONTINUE
      GO TO 84
   82 IMAX=I
      IMAXP1=I+1
      XTIPLE=XF(IMAX)
      YTIPLE= YF(IMAX)
      XTIPTE=XF(IMAXP1)
      YTIPTE= YF(IMAXP1)
      GO TO 84
   83 XTIPLE=XF(IMAX)
      XTIPTE=XTIPLE
   84 CONTINUE
C
C
C
C        ALFAC =INCLUDED ANGLE OF ATTACK,  PHI=ROLL ANGLE BOTH IN DEGREE
C        ES = PERMISSIBLE RELATIVE ERROR IN THE PATH INTEGRATION SCHEME
C
      READ(5,6)ALFAC,PHI,ES,VRTMAX
      IF (VRTMAX.EQ.0.0) VRTMAX=0.35
C
C  .. X-STATIONS,INTEGRATION INFO, + INITIAL VORTEX POSITIONS AND STRENG
C
C
C        NVV = TOTAL NUMBER OF VORTICES AT EACH X-STATION
C
C
C
      READ(5,30)(NVV(I),I=1,NIP)
      NV=NVV(1)
      NVMAX=NVV(NIP)
C
C        READ IN CROSSFLOW STARTING COORDINATES AND STRENGTHS FOR ALL
C        VORTICES REGARDLESS OF THE X-STATION AT WHICH THEY START.
C     THIS INFO MUST BE INPUT FOR INCREASING X-STATION.
C     HERE....VX(I)..Y-COORDINATE
C             VY(I)..Z-COORDINATE
C             G(I)...GAMMA/VINF,COUNTERCLOCKWISE POSITIVE,
C                    WHEN VIEWING FORWARD.
C
      READ(5,7)(VX(I),VY(I),G(I),I=1,NVMAX)
      DO 8 I=1,NV
      J=2*I-1
      K=J+1
      VXP(1,I,1)=VX(I)
      VXP(1,I,2)=VY(I)
      XO(J)=VX(I)
    8 XO(K)=VY(I)
C
C        XIP= X- VALUES AT THE NIP X-STATIONS AT WHICH OUTPUT REQD.
C        FIRST VALUE FOR XIP CAN BE ANY NUMBER LARGER THAN ZERO
C        INTEGRATION STARTS AT XIP(1)
C        INTEGRATION STEP SIZE DETERMINED BY DASCRU...M
```

```
C
      READ(5,6)(XIP(I),I=1,NIP)
C
C
      WRITE(6,1)TITLE
      IF (NF.NE.0)
     1WRITE (6,704) YMAX,CRP,XF(1),YF(1),XTIPLE,YTIPLE,XTIPTE,YTIPTE,
     1 XF(NF),YF(NF)
      WRITE(6,11)ALFAC,PHI
      IF (NOUT.NE.0) WRITE (6,DEBUG)
C
C
C     READ NUMBERS OF WING LEADING EDGE VORTEX INFO STATIONS XLE FOR
C     EACH WING.
C     FOR EACH XLE STATION,READ IN YBAR AND STRENGTH OF THE VORTICITY
C     DISTRIBUTION.
C
C  NOTE: XLE AND XSE ARE READ IN IN THE WING COORDINATE SYSTEM AND
C     MUST BE TRANSFORMED TO BODY COORDINATE SYSTEM.
C
      READ (5,4) MSWR,MSWL
      NEDGV=MSWR+MSWL
      IF (NEDGV.EQ.0) GO TO 19
                      READ (5,7) (XLE(IFV),CGLOC(IFV),GAMLE(IFV),
     1  IFV=1,NEDGV)
      WRITE (6,706)
      DO 15 JLE=1,NEDGV
      XLE(JLE)=XLE(JLE)+XF(1)
   15 WRITE (6,705) JLE,XLE(JLE),CGLOC(JLE),GAMLE(JLE)
   19 CONTINUE
C
C     READ NUMBER OF WING SIDE EDGE VORTEX INFO STATIONS XSE FOR EACH
C     WING.
C     FOR EACH XSE STATION,READ IN YBAR AND STRENGTH OF THE VORTICITY
C     DISTRIBUTION.
C
      READ (5,4) NCW
      NSIDGE=2*NCW
      IF (NSIDGE.EQ.0) GO TO 18
                      READ (5,7) (XSE(JSE),CGSELC(JSE),GAMSE(JSE),
     1 JSE=1,NSIDGE)
      WRITE (6,707)
      DO 16 JSE=1,NSIDGE
      XSE(JSE)=XSE(JSE)+XF(1)
   16 WRITE (6,705) JSE,XSE(JSE),CGSELC(JSE),GAMSE(JSE)
   18 CONTINUE
C
C
C  NOTE: HERE  RLOC.....HORIZONTAL SEMI-AXIS.
C              BLOC.....VERTICAL SEMI-AXIS.
C
C
      WRITE (6,700) ES
      WRITE (6,25)
      WRITE(6,26)XIP(1)
      CALL SHAPE (XIP(1),RLOC,BLOC,SLOC,RPLOC)
      WRITE (6,9) RLOC,BLOC,SLOC
      WRITE(6,27)
      WRITE(6,22)(L,VX(L),VY(L),G(L),L=1,NV)
C
C        CONVERT ANGLES TO RADIANS
C
      AC=ALFAC*RAD
```

```
      BE=PHI*RAD
      PHI=BE
      AL=ASIN(SIN(AC)*COS(BE))
      BE=ASIN(SIN(AC)*SIN(BE))
C
C  ......COMPUTE VORTEX PATHS USING DASCRU INTEGRATION SUBROUTINE......
C
      NIP1=NIP-1
      H=XIP(2)-XIP(1)
      DO 20 I=1,NIP1
      I1=I+1
      NV=NVV(I)
      NVN=NVV(I1)
      NV1=NV+1
      N=2*NV
      A1=XIP(I)
      B1=XIP(I+1)
C
      CALL DASCRU(A1,B1,H,N,XO,NK,IER,ES,VRTMAX)
C
C        IF IER GREATER THAN 32,DASCRU HAD TROUBLE GETTING STEP SIZE,
C        THEN,RATHER THAN CONTINUING WITH THE INTEGRATION, STOP 40
C        REDUCE XIP(2)-XIP(1)AND RERUN
C
      IF (IER.GE.32) GO TO 28
      GO TO 29
   28 WRITE (6,701)
      STOP 40
   29 CONTINUE
C
C
C  .. ADD THE NEW VORTICES AND THEIR POSITIONS FOR THE NEXT X-INTERVAL
C
      IF(NVN.EQ.NV)GO TO 39
      DO 35 K1=NV1,NVN
      JL=2*K1-1
      KK=JL+1
      XO(JL)=VX(K1)
   35 XO(KK)=VY(K1)
   39 CONTINUE
C
C  .. OUTPUT VORTEX POSITIONS AND CONFIGURATION CHARACTERISTICS AT THIS
C     STATION.
C
      WRITE(6,21)I1,B1,H
      CALL SHAPE (B1,RLOC,BLOC,SLOC,HPLOC)
      WRITE (6,9) RLOC,BLOC,SLOC
C
C  SAVE BODY POINTS FOR PLOT
C
      XPLT(1,I1)=B1
      YPLT(1,I1)=RLOC
      ZPLT(1,I1)=HLOC
      YPLT(2,I1)=SLOC
      WRITE(6,27)
      DO 23 L=1,NVN
      J=2*L-1
      K=J+1
      VXP(I1,L,1)=XO(J)
      VXP(I1,L,2)=XO(K)
      WRITE(6,22)L,XO(J),XO(K),G(L)
C
C  SAVE VORTEX LOCATION FOR PLOT
```

```
C
      JCV=NIP1+L+1
      XPLT(I,JCV)=B1
      YPLT(I,JCV)=XU(J)
      ZPLT(I,JCV)=XU(K)
   23 CONTINUE
   20 CONTINUE
C
C  PLOT VORTEX LOCATIONS
C
      XPLT(1,1)=XIP(1)
      IF (IPLT.GT.0)
     * CALL PLOTVB(XPLT,YPLT,ZPLT,NPLT,NIP1,NVN,30,ROT,XF,YF,NF,XP2,YP2,
     *             IPLT)
C
C..COMPUTE VELOCITIES AT THE SPECIFIED CONTROL POINTS INDUCED BY NV
C    EXTERNAL VORTICES AND THEIR IMAGES.
C
C
C  NOTE: IF CONTROL POINTS ARE PASSED THROUGH BY MEANS OF A DATA SET
C      I.E. WHEN NCPIN IS NOT EQUAL TO 0,     INDEX NCP IS READ IN FROM
C      THE DATA SET ALSO.
C  NOTE:X-COORDINATE OF CONTROL POINT MUST THEN BE TRANSFORMED TO BODY
C      COORDINATE SYSTEM.
C      THIS IS DONE BELOW.
C
C
      NCP=0
      IF (NCPIN.NE.0) REWIND 4
      IF (NVLOUT.NE.0) REWIND 7
      IF (NCPIN.EQ.0) GO TO 72
      IF (NCPIN.NE.0) READ (4,745) NCP
      IF (EOF(4).NE.0) GO TO 99
      GO TO 73
   72 READ (5,4) NCP
   73 CONTINUE
      IF(NCP.EQ.0)GO TO 99
      WRITE(6,31)
      DO 69 J11=1,NCP
      IF (NCPIN.EQ.0) GO TO 70
      READ (4,745) IC,CPX,CPY,CPZ
      CPX=CPX+XF(1)
      GO TO 71
   70 READ(5,60)CPX,CPY,CPZ
   71 CONTINUE
C
C.. DETERMINE THE X-STATIONS ADJACENT TO THE CONTROL POINT
C
      DO 61 I=1,NIP
      IF (CPX.LT.XIP(1)) GO TO 69
      J=I-1
      IF (I.EQ.1) J=1
      IF(CPX.LE.XIP(I))GO TO 62
   61 CONTINUE
C
C  DETERMINE BY INTERPOLATION THE POSITION IN THE CROSSFLOW PLANE OF ALL
C      VORTICES AT EACH STATION CPX.
C
   62 K=J+1
      X1=XIP(J)
      X2=XIP(K)
      WT1=(X2-CPX)/(X2-X1)
      WT2=(CPX-X1)/(X2-X1)
```

```
      NV=NVV(J)
      CALL SHAPE (CPX,RB,BL,SL,RPL)
      IF (NOUT.NE.0) WRITE (6,703)
      DO 63 I=1,NV
      VX(I)=WT1*VXP(J,I,1)+WT2*VXP(K,I,1)
      VY(I)=WT1*VXP(J,I,2)+WT2*VXP(K,I,2)
      IF (NOUT.EQ.0) GO TO 63
      WRITE (6,702) I,VX(I),VY(I)
   63 CONTINUE
C
      THETP=ATAN2(CPZ,CPY)
      SINTH=SIN(THETP)
      COSTH=COS(THETP)
      RCPT=SQRT(CPY*CPY+CPZ*CPZ)
      RBODY=SQRT(1.0/((SINTH/BL)**2+(COSTH/RB)**2))
      IF (RCPT.LE.RBODY) GO TO 64
      GO TO 65
   64 RBODYP=1.01*RBODY
      CPY=RBODYP*COSTH
      CPZ=RBODYP*SINTH
   65 CONTINUE
C
C     SUBROUTINE VVELS CALCULATES VELOCITIES INDUCED BY EXTERNAL
C     VORTICES AROUND ELLIPTICAL CROSS SECTION BODY BY SETTING S=RB IN
C     THE ARGUMENT LIST.
C
      CALL VVELS(NV,CPY,CPZ,VX,VY,G,RB,BL,RB,V,W,VRTMAX)
      WRITE(6,32) J11,CPX,CPY,CPZ,V,W
      IF (NVLOUT.EQ.0) GO TO 69
      IC=J11
      WRITE (7,746) IC,CPX,CPY,CPZ,V,W
   69 CONTINUE
      GO TO 99
    2 STOP
      END
```

```
      SUBROUTINE DASCRU (A,B,H,N,X0,WK,IER,ES,VRTMAX)
C
C     THIS SUBROUTINE PERFORMS INTEGRATION
C
C                                    ES SHOULD BE SET TO .5 TIMES THE
C                                    DESIRED RELATIVE PRECISION OF
C                                    THE SOLUTION
C
      DIMENSION             WK(1),X0(1)
C
      INTEGER               SW
C
      LOGICAL               BE,BH,BR,BX
C
      DATA                  ZERO,P5,OP5,THREE,FOUR/0.,.5,1.5,3.,4./
C
      IER = 0
      IF(A - B) 4,100,4
    4 IH1=N+N
      IH2=IH1+N
      HMIN=0.01*ABS(H)
```

```
      BH=.TRUE.
      BR=.TRUE.
      BX=.TRUE.
C
C                                   CHECK FOR THE PROPER SIGN OF H
C
      H=SIGN(ABS(H),B-A)
      X=A
    5 XS=X
      DO 10  J=1,N
         IJK0=N+J
         WK(IJK0)=X0(J)
   10 CONTINUE
   15 HS=H
      Q=X+H-B
      BE=.TRUE.
      IF(.NOT.((H.GT.ZERO.AND.Q.GE.ZERO).OR.(H.LT.ZERO.AND.Q.LE.ZERO)))
     1      GO TO 20
      H=B-X
      BR=.FALSE.
   20 H3=H/THREE
C
C                                   CALCULATE SOLN. AT X+H
C   NOTE: ARRAY WK CONTAINS V FOR ODD INDEX,W FOR EVEN INDEX.
C
C
      DO 90  SW=1,5
         CALL F(X0,X,N,WK,VDTMAX)
         DO 70  I=1,N
            Q=H3*WK(I)
            IJK0=N+I
            IJK1=IM1+I
            IJK2=IM2+I
            GO TO (25,30,35,40,45),SW
   25       R=Q
            WK(IJK1)=Q
            GO TO 50
   30       R=P5*(Q+WK(IJK1))
            GO TO 50
   35       R=THREE*Q
            WK(IJK2)=R
            R=.375*(R+WK(IJK1))
            GO TO 50
   40       R=WK(IJK1)+FOUR*Q
            WK(IJK1)=R
            R=OP5*(R-WK(IJK2))
            GO TO 50
   45       R=P5*(Q+WK(IJK1))
            G= ABS(R+R - OP5*(Q+WK(IJK2)))
   50       X0(I)=WK(IJK0)+R
            IF(SW.NE.5) GO TO 70
C
C                                   AUTOMATIC STEP CHANGE
C
            E=ABS(X0(I))
            R=E5
            IF(E.GE.1.E-3) R=E*E5
C
C                                   TEST ADJUSTMENT OF THE STEP
C
            IF(G.LT.R.OR.(.NOT.BX)) GO TO 65
            BR=.TRUE.
            BH=.FALSE.
```

```
          H=P5*H
          IF(ABS(H).GE.HMIN) GO TO 55
C
C                                  THE STEP IS HALVED RESTORE X AND X0,
C                                  AND GO BACK FOR REPEATED INTEGRATION
C                                  WITH THIS NEW STEP
C
          H=SIGN(1.,H)*HMIN
          BX=.FALSE.
   55     DO 60  J=1,N
            IJKO=N+J
            X0(J)=W(IJKO)
   60     CONTINUE
          X=XS
          GO TO 15
   65     IF(Q.GE.0.03125*R) BE=.FALSE.
   70   CONTINUE
        GO TO (75,90,80,85,90),SW
   75   X=X+H3
        GO TO 90
   80   X=X+P5*H3
        GO TO 90
   85   X=X+P5*H
   90 CONTINUE
C
C                                  TEST A POSSIBLE DOUBLING OF THE STEP
C
      IF(.NOT.(BE.AND.BH.AND.BR)) GO TO 95
      H=H+H
      BX=.TRUE.
   95 BH=.TRUE.
      IF(BR) GO TO 5
      H=HS
      IF(BX .OR. BE) GO TO 9005
      IER = 33
      GO TO 9005
  100 DO 105 I=1,N
        X0(I)=ZERO
  105 CONTINUE
 9005 RETURN
      END
```

```
      COMPLEX FUNCTION DBLU(Z)
C
C     THIS FUNCTION SUBROUTINE CALCULATES THE INTERMEDIATE TRANSFORM
C     VARIABLE W FOR THE CONFORMAL TRANSFORMATION OF AN ELLIPTICAL
C     BODY WITH WINGS TO A CIRCLE.
C
      COMMON/COM1/A2,B2,R2
      COMMON/COM3/ZR,ZI
      COMMON/COM5/DWDZ
      COMMON/COM6/W2,W
      COMMON/PARAM/NOUT
C
      COMPLEX Z,Z2,DWDZ,W,W2,WW
C
  700 FORMAT (//19X,2HZ2,22X,4HDWDZ/14X,2HRE,9X,2HIM,11X,2HRE,9X,2HIM)
  701 FORMAT (10X,F10.5,1X,F10.5,2X,F10.5,1X,F10.5)
C
```

```
C
      IF (NOUT.EQ.2) WRITE (6,700)
      Z2=Z*Z
      ZR=REAL(Z)
      ZI=AIMAG(Z)
      IF(ZR.NE.0.0) ZR=ZR/ABS(ZR)
      IF(ZI.NE.0.0) ZI=ZI/ABS(ZI)
      Z2=Z2-A2+B2
      IF (NOUT.EQ.2) WRITE (6,701) Z2
      Y=AIMAG(Z2)
      AY=1.0
      IF(Y.LT.0.0) AY=-1.0
      AYZ=1.0
      IF(ZI.LT.0.0) AYZ=-1.0
      Z2=CSQRT(Z2)*AY*AYZ
      IF (NOUT.EQ.2) WRITE (6,701) Z2
      IF((ABS(ZI).LE.0.0).AND.(REAL(Z).LT.0.0)) Z2=CMPLX(-REAL(Z2),
     1       AIMAG(Z2))
      DWDZ=0.5*(1.0+Z/Z2)
      IF (NOUT.EQ.2) WRITE (6,701) Z2,DWDZ
      WW=0.5*(Z+Z2)
      W2=1.0/(WW*WW)
      DBLU=WW
      RETURN
      END
```

```
      COMPLEX FUNCTION DSDZ(S)
C
C     CALCULATE DZETA/DTAU
C
      COMMON/COM2/SIG2,H2
      COMMON/COM5/DWDZ
      COMMON/COM4/G2,G1
      COMMON/COM6/W2,W
      COMPLEX W,W2,DWDZ,G1,G2
      DSDZ=0.5*(1.0-SIG2*W2)*(1.0+G1/G2)*DWDZ
      RETURN
      END
```

```
      COMPLEX FUNCTION DZDS(S)
C
C     CALCULATE DZ/DZETA
C
      COMMON/COM1/A2,B2,R2
      COMMON/COM2/SIG2,H2
      COMMON/COM6/W2,W
      COMPLEX W,S,W2,G1,S2,Z,Z2
      S2=S*S
      G1=0.5*(1.0-0.25*(A2-H2)**2)*(1.0-R2/S2)
      Z=S+R2/S
      Z2=Z*Z-4.0*SIG2
      Y=AIMAG(Z)
      YZ=AIMAG(Z2)
      AY=1.0
      AYZ=1.0
```

```
      IF(Y.LT.0.0) AY=-1.0
      IF(YZ.LT.0.0) AYZ=-1.0
      Z2=CSQRT(Z2)*AY*AYZ
      IF((ABS(Y).LE.0.0).AND.(REAL(Z).LT.0.0)) Z2=CMPLX(-REAL(Z2),
     1       AIMAG(Z2))
      DZDS=G1*(1.0+Z/Z2)
      RETURN
      END
```

```
      COMPLEX FUNCTION D2SDZ2(S)
C
C     CALCULATE DZETA2/DZ2
C
      COMMON/COM2/SIG2,H2
      COMMON/COM4/G2,G1
      COMMON/COM6/W2,W
      COMMON/COM5/DWDZ
      COMPLEX W,W2,DWDZ,G2,G1
      D2SDZ2=(1.0+G1/G2)*SIG2**2/W
      D2SDZ2=D2SDZ2-0.5*(1.0-SIG2**2)*(1.0-SIG2*W2)*H2/(G2*(G1*G1-H2))
      D2SDZ2=D2SDZ2*DWDZ*DWDZ
      RETURN
      END
```

```
      SUBROUTINE EXPAND(RP,X,Y,VS,WS)
C
C     THIS SUBROUTINE CALCULATES VELOCITIES INDUCED BY EXPANDING OR
C     CONTRACTING ELLIPTICAL CROSS SECTION.
C
      COMMON/COM1/A2,B2,R2
      COMMON/BLK1/A,R,S,PI,CI
      COMMON/COM8/RFACT
      COMPLEX VE,Z,ZI,CI
      SP=RFACT*A*RP
      Z=CMPLX(X,Y)
      ZI=Z*Z
      AY=1.0
      IF(AIMAG(Z).LT.0.0) AY=-1.0
      AYZ=1.0
      IF(AIMAG(ZI).LT.0.0) AYZ=-1.0
      Z=CSQRT(ZI-A2+B2)*AY*AYZ
      IF((ABS(AIMAG(Z)).LE.0.0).AND.(REAL(Z).LT.0.0))
     1       Z=CMPLX(-REAL(Z),AIMAG(Z))
      VE=SP/Z
      VS=REAL(VE)
      WS=-AIMAG(VE)
      RETURN
      END
```

```
      SUBROUTINE F(XO,PX,N,WK,VRTMAX)
C
C     THIS SUBROUTINE IS CALLED BY DASCRU TO CALCULATE CROSS FLOW
C     PLANE VELOCITIES
C
      COMPLEX CI,Z,FCT,SIMP
      COMMON/VEL/AL,BE,          VX(30),VY(30),G(30),NV,      NS,NF,
     1XE(7),XF(7),YF(7),C(7,7),IFIN
      COMMON/BLK1/A,B,S,PI,CI
      COMMON/BLK2/AC,PHI
      COMMON/FINLE/YLE(80),CGLUC(80),GAMLE(80),MSWR,MSWL,MSWU,MSWD,
     1 NEDGV,XTIPLE
      COMMON/SIDEDG/YSE(80),CGSELC(80),GAMSE(80),NCW,NSIDGE,XTIPTE
      COMMON/COM1/A2,B2,R2
      COMMON/COM2/SIG2,H2
      COMMON/COM7/B [illegible] VT
      COMMON/COM9/IGROW
      COMMON/PARAM/NOUT
C
      DIMENSION XO(1),WK(1),V(30),W(30),VV(30),WW(30)
C
C
      EXTERNAL Z,FCT,SIMP
C
      NAMELIST/DEBUG/X,Y,YVINT,ZVBAR,GAMINT,A,B,VRTMAX,VS,WS
C
      CI=CMPLX(0.,1.)
      PI=3.14159265
      DO 888 I=1,NV
      J=2*I-1
      K=J+1
      VX(I)=XO(J)
  888 VY(I)=XO(K)
      CALL SHAPE(PX,A,B,S,RP)
C
C     NOTE: COORDINATE VX(I) IS THE Y-COORDINATE IN THE CROSS FLOW PLANE,
C           COORDINATE VY(I) IS THE Z-COORDINATE IN THE CROSS FLOW PLANE.
C
C     COMPUTE VELOCITIES IN THE CROSSFLOW PLANE ...
C        V(I) IS IN THE Y-DIRECTION.
C        W(I) IS IN THE Z-DIRECTION.
C
C
      A2=A*A
      B2=B*B
      APB=A+B
      APB2=APB*APB
      R1=S+SQRT(S*S-A2+B2)
      R=0.25*(R1+APB2/R1)
      H=R+R
      H2=H*H
      SIG=0.5*APB
      SIG2=SIG*SIG
      R2=R*R
      DO 100 I=1,NV
      X=VX(I)
      Y=VY(I)
      VS=0.
      WS=0.
C
C     COMPUTE VELOCITIES IN CROSS FLOW PLANE DUE TO ANGLE OF PITCH AND
C     ANGLE OF SIDESLIP.
C
```

```
      IF (NOUT.EQ.3) WRITE (6,DEBUG)
      IF((AL.NE.0.0).OR.(BE.NE.0.0)) CALL PITROL(AL,BE,X,Y,VS,WS)
      IF (NOUT.EQ.3) WRITE (6,DEBUG)
      V(I)=VS
      W(I)=WS
C
C     COMPUTE VELOCITIES IN CROSSFLOW PLANE DUE TO EXPANDING BODY
C
      VS=0.0
      WS=0.0
      IF(IGROW.GT.0) CALL EXPAND(RP,X,Y,VS,WS)
      IF (NOUT.EQ.3) WRITE (6,DEBUG)
      V(I)=V(I)+VS
      W(I)=W(I)+WS
C
C     IF WING LE  VORTICITY IS INCLUDED,DETERMINE BY INTERPOLATION THE
C     EFFECTS OF THE SPECIFIED VORTICITY.
C
C NOTE: HERE IFIN=1,...RIGHT WING
C                 2,...LEFT WING
C
      IF (NEDGV.EQ.0) GO TO 20
      IFIN=1
      KSTART=1
      KUL=MSWR
   23 CONTINUE
      IF (IFIN.EQ.2) KSTART=MSWR+1
      DO 21 IFV=KSTART,KUL
      IF (PX.LT.XLE(KSTART)) GO TO 20
      JV=IFV-1
      IF (IFV.EQ.1) JV=1
      IF (PX.LE.XLE(IFV)) GO TO 22
   21 CONTINUE
      IF (PX.LE.XTIPLE) GO TO 38
      GO TO 20
   22 KV=JV+1
      X1=XLE(JV)
      X2=XLE(KV)
      WT1=(X2-PX)/(X2-X1)
      WT2=(PX-X1)/(X2-X1)
      YVINT=WT1*CGLOC(JV)+WT2*CGLOC(KV)
      ZVBAR=(PX-XF(1))*TAN(AL/2.0)
      GAMINT=WT1*GAMLE (JV)+WT2*GAMLE (KV)
      IF (NOUT.EQ.3) WRITE (6,DEBUG)
      GO TO 39
   38 GAMINT=GAMLE(KUL)
      YVINT=CGLOC(KUL)
      ZVBAR=(PX-XF(1))*TAN(AL/2.0)
      IF (NOUT.EQ.3) WRITE (6,DEBUG)
   39 CALL VVEL3(1,X,Y,YVINT,ZVBAR,GAMINT,A,B,S,VS,WS,VRTMAX)
      IF (NOUT.EQ.3) WRITE (6,DEBUG)
      V(I)=V(I)+VS
      W(I)=W(I)+WS
      IFIN=IFIN+1
      IF(IFIN.GT.2) GO TO 20
      KUL=MSWR+MSWL
      GO TO 23
   20 CONTINUE
C
C
C     IF WING SE VORTICITY IS INCLUDED,DETERMINE BY INTERPOLATION THE
C     EFFECTS OF THE SPECIFIED VORTICITY.
C
```

```
      IF (NSIDGE.EQ.0) GO TO 28
      IFIN=1
      KSTART=1
      KUL=NCW
   27 CONTINUE
      IF (IFIN.EQ.2) KSTART=NCW+1
      DO 29 JSE=KSTART,KUL
      IF (PX.LT.XSE(KSTART)) GO TO 28
      JVSE=JSE-1
      IF (JSE.EQ.1) JVSE=1
      IF (PX.LE.XSE(JSE)) GO TO 30
   29 CONTINUE
      IF (PX.LE.XTIPTE) GO TO 51
      GO TO 28
   30 KVSE=JVSE+1
      X1=XSE(JVSE)
      X2=XSE(KVSE)
      WT1=(X2-PX)/(X2-X1)
      WT2=(PX-X1)/(X2-X1)
      VVINT=WT1*CGSELC(JVSE)+WT2*CGSELC(KVSE)
      ZVBAR=(PX-XF(1))*TAN(AL/2.0)
      GAMINT=WT1*GAMSE(JVSE)+WT2*GAMSE(KVSE)
      IF (NOUT.EQ.3) WRITE (6,DEBUG)
      GO TO 59
   51 GAMINT=GAMSE(KUL)
      VVINT=CGSELC(KUL)
      ZVBAR=(PX-XF(1))*TAN(AL/2.0)
      IF (NOUT.EQ.3) WRITE (6,DEBUG)
   59 CALL VVELS(I,X,Y,VVINT,ZVBAR,GAMINT,A,B,S,VS,WS,VRTMAX)
      IF (NOUT.EQ.3) WRITE (6,DEBUG)
      V(I)=V(I)+VS
      W(I)=W(I)+WS
      IFIN=IFIN+1
      IF(IFIN.GT.2) GO TO 28
      KUL=2*NCW
      GO TO 27
   28 CONTINUE
  100 CONTINUE
C
C     CALCULATE VELOCITIES INDUCED BY ALL VORTICES ON ONE VORTEX IN THE
C     PRESENCE OF AN ELLIPTICAL BODY-MONOPLANE WING.
C
      CALL VOTEX(NV,VX,VY,G,VV,WW)
      CAL=COS(AC)
      DO 101 I=1,NV
      V(I)=V(I)+VV(I)
      W(I)=W(I)+WW(I)
      J=2*I-1
      K=J+1
      WK(J)=V(I)/CAL
      WK(K)=W(I)/CAL
  101 CONTINUE
      RETURN
      END


      SUBROUTINE PITROL(AL,BE,X,Y,VS,WS)
C
C     THIS SUBROUTINE COMPUTES THE CROSSFLOW COMPONENTS FOR A WINGED
C     ELLIPTICAL BODY AT ANGLE OF ATTACK,AL, AND SIDESLIP ANGLE, BE.
C
      COMMON/BLK1/A,B,S,PI,CI
```

```
      COMPLEX SZ,CI,ZA,SQ,SQS,VELAL,Z,DSDZ
      EXTERNAL Z,DSDZ
      RR=R*R
      ZA=CMPLX(X,Y)
      SZ=Z(ZA)
      SQ=SZ*SZ
      SQS=DSDZ(ZA)
      VELAL=CMPLX(0.0,0.0)
      IF(AL.NE.0.0) VELAL=-CI*SIN(AL)*(1.0+RR/SQ)*SQS+VELAL
      IF(BE.NE.0.0) VELAL=VELAL-SIN(BE)*(1.0-RR/SQ)*SQS
      VS=REAL(VELAL)
      WS=-AIMAG(VELAL)
      RETURN
      END


      SUBROUTINE PLOTVB(X,Y,Z,NP,NIP1,NVN,NDP,ROT,XF,YF,NF,X2,Y2,IOPT)
C
C  ROUTINE TO GENERATE A PLOT VORTEX LOCATION RELATIVE TO
C  THE WING-BODY CONFIGURATION
C  DEFINITIONS:
C    NC    = INDEX OF CURVE
C    NIP1 = NO. OF BODY STATIONS
C    NVN  = NO. OF VORTICES
C    NF   = NO. OF WING DEFINITON CARDS
C
      DIMENSION X(NDP,52),Y(NDP,52),Z(NDP,52)
      DIMENSION NP(52),ROT(3),XCG(3),XF(7),YF(7)
      DIMENSION X2(17,18),Y2(17,18),NP2(18),SYMBOL(40)
C
      DATA SYMBOL / 1H*,1H+,1H-,1H.,1H0,1H1,1H2,1H3,1H4,1H5,1H6,
     *  1H7,1H8,1H9,1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HI,1HJ,1HK,1HL,
     *  1HM,1HN,1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ/
C       LENG AND LWID GIVE A PLOT THAT IS 9"X10"
      DATA LWID,LENG,XCG/ 100,54, 0.,0.,0./
      IF (IOPT.LE.0) IOPT=5
C       1H0 WRITTEN HERE IS TO SUPPRESS THE AUTOMATIC PAGE EJECT
      WRITE(6,10)
      WRITE(6,11)
10    FORMAT(1H1)
11    FORMAT(1H0)
C
C  FIND MAXIMUM DIAMETER
C
      BMAX=0.
      DO 100 I=1,NIP1
100   BMAX=AMAX1(BMAX,Y(1,I+1),Z(1,I+1))
C
C  CURVE 1:  DRAW AXES
C
      NC=1
      DO 120 I=1,6
      X(I,1)=X(1,1)
      Y(I,1)=0.
120   Z(I,1)=0.
      X(2,1)=X(1,NIP1+1)
      Y(4,1)=1.5*BMAX
      Z(6,1)=1.5*BMAX
      NP(1)=6
C
C  CURVES:  2 TO NIP1+1
C  GENERATE CROSS SECTIONS
```

```
C
      NGV=NIP1+NVN+5
      MERID=17
      DO 160 J=1,NIP1
      NC=NC+1
      R1   =X(1,NC)
      RLOC=Y(1,NC)
      BLOC=Z(1,NC)
      SLOC=Y(2,NC)
C           SAVE RLOC AND BLOC
      Y(J,NGV)=RLOC
      Z(J,NGV+1)=BLOC
      Y(J,NGV+2)=SLOC
C
C  GENERATE ELLIPTIC BODY CROSS SECTION
C
      DTH=2.*3.1415926/(MERID-1)
      DO 140 I=1,MERID
      PHI=(I-1)*DTH
      RAD=(COS(PHI)/BLOC)**2+(SIN(PHI)/RLOC)**2
      RAD=SQRT(1./RAD)
      Y(I,NC)=RAD*SIN(PHI)
      Z(I,NC)=RAD*COS(PHI)
      X(I,NC)=R1
140   CONTINUE
160   NP(NC)=MERID
C
C  PLOT VORTEX LOCATION (ALREADY DEFINED)
C
      DO 170 I=1,NVN
      NC=NC+1
170   NP(NC)=NIP1
C
C  WING OUTLINE
C
      IF (NF.LE.0) GO TO 200
      DO 190 J=1,2
      NC=NC+1
      SGN=(-1)**(J+1)
      DO 180 I=1,NF
      X(I,NC)=XF(I)
      Y(I,NC)=YF(I)*SGN
      Z(I,NC)=0.0
180   CONTINUE
      NF1=NF+1
      X(NF1,NC)=XF(1)
      Y(NF1,NC)=YF(1)*SGN
      Z(NF1,NC)=0.0
      NP(NC)=NF1
190   CONTINUE
200   CONTINUE
C
C  PLOT CROSS SECTIONS WITH VORTEX LOCATIONS  ---------------------------
C
      DO 240 ISECTN=1,3
      IF (ISECTN.EQ.1) JSECTN=1
      IF (ISECTN.EQ.2) JSECTN=NIP1/2
      IF (ISECTN.EQ.3) JSECTN=NIP1
C
C  COPY BODY
C
      DO 220 I=1,MERID
      X2(I,1)=Y(I,JSECTN+1)
```

```
      Y2(I,1)=Z(I,JSECTN+1)
  220 CONTINUE
      NP2(1)=MERID
      NC2=1
C
C  WING OUTER BOUNDARIES
C
      SLOC=Y(JSECTN,NGV+2)
      X2(1,2)=SLOC
      Y2(1,2)=0.
      X2(2,2)=-SLOC
      Y2(2,2)=0.
      NP2(2)=2
      NC2=NC2+1
C
C  COPY VORTICES AT JSECTN
C
      DO 230 J=1,NVN
      NC2=NC2+1
      JCV=NIP1+1+J
      X2(1,NC2)=Y(JSECTN,JCV)
      Y2(1,NC2)=Z(JSECTN,JCV)
      NP2(NC2)=1
  230 CONTINUE
C
C  PLOT CROSS SECTIONS
C
      CALL PLOTA2(X2,Y2,3,NP2,17,NC2,LWID,LENG)
      WRITE(6,23) JSECTN,X(1,JSECTN+1)
      WRITE(6,24) (I,SYMBOL(I+2),I=1,NVN)
  240 CONTINUE
C
C  PLOT PERSPECTIVE VIEWS ----------------------------------------
      LENG = 50
      IOPT = 3
C
C  SIDE VIEW
      CALL PLOTA2(X,Z,3,NP,NDP,NC,LWID,LENG)
C     CALL PLOTV2(X,Z,3,NP,NDP,NC,LWID,LENG,LINE,NLIN)
      WRITE(6,21)
      NSYM=NVN
      JSYM=1+NIP1
      JN = JSYM+NVN
      IF (JN.GT.40) NSYM=JN-40
      WRITE(6,24) (I,SYMBOL(I+JSYM),I=1,NSYM)
      IF (JN.LE.40) GO TO 210
      JSYM=NSYM+1
      ISYM = NSYM
      WRITE(6,24) (I,SYMBOL(I+ISYM),I=JSYM,NVN)
  210 CONTINUE
      IOPT = 1
C
C  TOP VIEW
      CALL PLOTA2(X,Y,3,NP,NDP,NC,LWID,LENG)
C     CALL PLOTV2(X,Y,3,NP,NDP,NC,LWID,LENG,LINE,NLIN)
      WRITE(6,20)
C
C  PERSPECTIVE VIEW
      IOPT = 3
      ROT(1)=0.
      ROT(2)=30.
      ROT(3)=20.
```

```
      CALL PLOTA5(X,Y,Z,NP,NDP,NC,ROT,XCG,X,Y,3)
      CALL PLOTA2(X,Y,3,NP,NDP,NC,LNID,LENG)
C     CALL PLOTV2(X,Y,3,NP,NDP,NC,LNID,LENG,LINE,NLIN)
      WRITE(6,22) ROT
C
C
20    FORMAT(/20X,22HTOP VIEW  - Y VERSUS X)
21    FORMAT(/20X,22HSIDE VIEW - Z VERSUS X)
22    FORMAT(/20X,18HPERSPECTIVE - ROT=,3F10.2)
23    FORMAT(/20X,29HBODY CROSS SECTION  - JSECTN=,I3,
     *   5X,4HXIP=,F10.5)
24    FORMAT(20X,14HVERTEX SYMBOL:,10(1X,I2,1H=,A1,1H,))
C
C
      RETURN
      END


      SUBROUTINE SHAPE(X,R,B,S,RP)
C
C  THIS SUBROUTINE COMPUTES HORIZONTAL SEMI-MAJOR AXIS AND VERTICAL
C  SEMI-MAJOR AXIS AND WING SPAN MEASURED FROM THE BODY CENTERLINE.
C
C
C     IF ELLIPTICAL CROSS SECTION,B IS VERTICAL SEMI-AXIS
C                                 R IS HORIZONTAL SEMI-AXIS.
C
      COMMON/VEL/AL,BE,              VX(30),VY(30),G(30),NV,      NS,NF,
     1XF(7),XF(7),YF(7),C(7,7),IFIN
      COMMON/COMB/BFACT
      COMMON/COM9/IGROW
      IGROW=0
      IFIN=0
      DO 1 K=1,NS
      XL=XF(K)
      J=K
      IF(X.LE.XL)GO TO 2
    1 CONTINUE
    2 R=C(J,1)+X*C(J,5)+X*X*C(J,6)
      ARG=X*X*C(J,2)+X*C(J,3)+C(J,4)
      R=R+SQRT(ARG)*C(J,7)
      IF((C(J,5).GT.0.0).OR.(C(J,6).GT.0.0)) IGROW=1
      RP=C(J,5)+2.0*C(J,6)*X
      IF(ARG.LE.0.0) GO TO 5
      RP=RP+0.5*C(J,7)*(2.0*C(J,2)*X+C(J,3))/SQRT(ARG)
      IGROW=1
    5 CONTINUE
      S=R
      B=R*BFACT
      IF(NF.EQ.0)RETURN
      IF(X.LE.XF(1).OR.X.GT.XF(NF))RETURN
      IFIN=1
      DO 3 K=2,NF
      J=K
      XL=XF(K)
      IF(X.LE.XL)GO TO 4
    3 CONTINUE
    4 J1=J-1
      S=(X-XF(J1))*(YF(J)-YF(J1))/(XF(J)-XF(J1))+YF(J1)
      RETURN
      END
```

```
      SUBROUTINE VOTEX(NV,XV,YV,GV,VV,WV)
C
C   THIS SUBROUTINE COMPUTES THE PERTURBATION VELOCITY COMPONENTS AT THE
C     VORTEX LOCATIONS ACCOUNTING FOR MUTUAL EFFECTS AND THE PRESENCE
C     OF A WINGED ELLIPTICAL CROSS SECTION
C
      DIMENSION XV(30),YV(30),GV(30),VV(30),WV(30)
      DIMENSION VX(30),VY(30),G(30)
      COMMON/V/A4,R4
      COMMON/BLK1/A,B,S,PI,CI
      COMMON/COM7/B
      COMMON/COM1/AA,BB,RR
      COMMON/COM2/SIG2,H2
      COMPLEX CI,TO,Z,SO,DSDT,DTDS,D2SDT,V1,V2,V3,VEL,TAU,SI,SOB,SIB
     2,DSDZ,DZDS,D2SDZ2
      EXTERNAL Z,DSDZ,DZDS,D2SDZ2
      NN=NV-1
      AA=A*A
      BB=B*B
      APB=A+B
      APB2=APB*APB
      R1=S+SQRT(S*S-AA+BB)
      R=0.25*(R1+APB2/R1)
      H=R+R
      H2=H*H
      SIG=0.5*APB
      SIG2=SIG*SIG
      RR=R*R
      DO 100 I=1,NV
      XO=XV(I)
      YO=YV(I)
      GO=GV(I)
      K1=0
      DO 99 J=1,NV
      IF(J.EQ.I)GO TO 99
      K1=K1+1
      VX(K1)=XV(J)
      VY(K1)=YV(J)
      G(K1)=GV(J)
   99 CONTINUE
      TO=CMPLX(XO,YO)
      SO=Z(TO)
      SOB=CONJG(SO)
      DSDT=DSDZ(SO)
      DTDS=DZDS(SO)
      D2SDT=D2SDZ2(SO)
      V1=-GO*DTDS*D2SDT/2.
      V2=GO*DSDT*SOB/(SOB*SO-RR)
      V3=CMPLX(0.,0.)
      DO 3 K=1,NN
      TAU=CMPLX(VX(K),VY(K))
      SI=Z(TAU)
      SIB=CONJG(SI)
    3 V3=V3-G(K)*(1./(SO-SI)-SIB/(SO*SIB-RR))*DSDT
      VEL=CI*(V1+V2+V3)/(PI+PI)
      VV(I)=REAL(VEL)
      WV(I)=-AIMAG(VEL)
  100 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE VVELS(NV,YY,ZZ,VX,VY,G,AB,BB,S,V,W,VRTMAX)
C
C     THIS SUBROUTINE COMPUTES PERTURBATION VELOCITY COMPONENTS DUE TO
C     NV EXTERNAL VORTICES AND THEIR IMAGES INSIDE A BODY WITH
C     ELLIPTICAL CROSS SECTION WITH OR WITHOUT MONO-PLANE WING.
C
C
      DIMENSION VX(1),VY(1),G(1)
C
      COMMON/COM1/A2,B2,R2
      COMMON/COM2/SIG2,H2
      COMMON/PARAM/NOUT
C
      COMPLEX T0,V1,DSDT,Z,DSDZ,SI,SIB,S0,TAU,CI,VEL
C
      EXTERNAL Z,DSDZ
C
  700 FORMAT (5X,I5,5X,F10.5,1X,F10.5, 4(2X,F10.5,1X,F10.5))
  701 FORMAT (//6X,4HIVRT,15X,2HSI,21X,3HSIB,21X,2HV1,21X,4HDSDT,21X,
     1 2HS0/
     1 19X,2HRE,9X,2HIM,10X,2HRE,9X,2HIM,11X,2HRE,9X,2HIM,11X,2HRE,
     1  9X,2HIM)
C
      PI=3.14159265
      TLC=0.001
      CI=CMPLX(0.0,1.0)
      A2=AB*AB
      B2=BB*BB
      APB=AB+BB
      APB2=APB*APB
      R1=S+SQRT(S*S-A2+B2)
      R=0.25*(R1+APB2/R1)
      R2=R*R
      H=R+R
      H2=H*H
      SIG=0.5*APB
      SIG2=SIG*SIG
      T0=CMPLX(YY,ZZ)
      S0=Z(T0)
      V1=CMPLX(0.0,0.0)
      DSDT=DSDZ(S0)
C
C     LOOP OVER THE NUMBER OF VORTICES,NV
C
      IF (NOUT.GE.2) WRITE (6,701)
      DO 1 I=1,NV
      TAU=CMPLX(VX(I),VY(I))
      SI=Z(TAU)
      SIB=CONJG(SI)
      D=CABS(SI-S0)
      IF(D.LE.TLC) GO TO 2
      V1=V1-G(I)/(S0-SI)
    2 CONTINUE
      D=CABS(S0-R2/SIB)
      IF(D.LE.TLC) GO TO 1
      V1=V1+G(I)/(S0-R2/SIB)
      IF (NOUT.GE.2) WRITE (6,700) I,SI,SIB,V1,DSDT,S0
    1 CONTINUE
C
      VEL=0.5*CI*V1*DSDT/PI
      V=REAL(VEL)
      W=-AIMAG(VEL)
      AV=ABS(V)
```

```
      AW=ABS(W)
      IF(V.GT.0.0.AND.AV.GE.VRTMAX) V=VRTMAX
      IF(V.LT.0.0.AND.AV.GE.VRTMAX)V=-VRTMAX
      IF(W.GT.0.0.AND.AW.GE.VRTMAX) W=VRTMAX
      IF(W.LT.0.0.AND.AW.GE.VRTMAX)W=-VRTMAX
      RETURN
      END




      COMPLEX FUNCTION Z(CT)
C
C     THIS FUNCTION SUBROUTINE CALCULATES THE ZETA  VALUE IN THE
C     TRANSFORMED (CIRCLE) PLANE FOR GIVEN TAU IN THE PHYSICAL PLANE
C     FOR AN ELLIPTICAL BODY WITH WINGS
C
      COMMON/COM2/SIG2,H2
      COMMON/COM3/ZR,ZI
      COMMON/COM4/G2,G1
      COMMON/COM6/W2,W
      COMMON/PARAM/NOUT
C
      COMPLEX W,G1,G2,CT,W2,DBLU
C
  700 FORMAT (//19X,2HG1,22X,2HG2/14X,2HRE,9X,2HIM,11X,2HRE,9X,2HIM)
  701 FORMAT (10X,F10.5,1X,F10.5,2X,F10.5,1X,F10.5)
C
      EXTERNAL DBLU
C
      W=DBLU(CT)
      G1=W+SIG2/W
      G2=G1*G1-H2
      IF(NOUT.EQ.2) WRITE (6,700)
      IF (NOUT.EQ.2) WRITE (6,701) G1,G2
      Y=AIMAG(G2)
      AY=1.0
      IF(Y.LT.0.0) AY=-1.0
      YZ=AIMAG(G1)
      AYZ=1.0
      IF(YZ.LT.0.0)AYZ=-1.0
      G2=CSQRT(G2)*AY*AYZ
      IF (NOUT.EQ.2) WRITE (6,701) G1,G2
      IF((ABS(YZ).LE.0.0).AND.(REAL(G1).LT.0.0)) G2=CMPLX(-REAL(G2),
     1     AIMAG(G2))
      IF (NOUT.EQ.2) WRITE (6,701) G1,G2
      Z=0.5*(G1+G2)
      IF((ABS(ZI).NE.0.0).AND.(ABS(ZR).NE.0.0)) Z=CMPLX(ZR*ABS(REAL(Z)),
     1ZI*ABS(AIMAG(Z)))
      RETURN
      END
```

REFERENCES

1. Dillenius, Marnix F. E., Nielsen, Jack N.: Supersonic Lifting-Surface Computer Program for Cruciform Wing-Body Combinations in Combined Pitch and Sideslip. Office of Naval Research, Contract No. N00014-74-C-0050, Annual Report, December 1974 (also NEAR TR 74).

2. Dillenius, Marnix F. E., Nielsen, Jack N.: Prediction of Aerodynamics of Missiles at High Angles of Attack in Supersonic Flow. Office of Naval Research, Contract No. N00014-74-C-0050, Annual Report, October 1975 (also NEAR TR 99).

3. Polhamus, E. C.: Prediction of Vortex-Lift Characteristics Based on a Leading-Edge Suction Analogy. AIAA paper no. 69-1133, October 1969 (Jour. of Aircraft, vol. 8, no. 4, April 1971, pp. 193-199).

4. Mendenhall, Michael R., Nielsen, Jack N.: Effect of Symmetrical Vortex Shedding on the Longitudinal Aerodynamic Characteristics of Wing-Body-Tail Combinations. NASA CR-2473, Jan. 1975.

5. Spangler, Selden B., Mendenhall, Michael R.: Further Studies of Aerodynamic Loads at Spin Entry. Office of Naval Research, Contract No. N00014-74-C-0344, Annual Report, May 1, 1977 (also NEAR TR 141).

6. Woodward, F. A. and Larson, J. W.: A Method of Optimizing Camber Surfaces for Wing-Body Combinations at Supersonic Speeds. Part 1 - Theory and Application. NASA CR-69181, 1965.

7. Dillenius, Marnix F. E., Goodwin, Fred K., Nielsen, Jack N.: Prediction of Supersonic Store Separation Characteristics. Vol. 1 - Theoretical Methods and Comparisons with Experiment. AFFDL-TR-76-41, vol. 1, May 1976.

8. Nielsen, J. N.: Missile Aerodynamics. McGraw-Hill Book Co., 1960.

9. Woodward, F. A.: An Improved Method for the Aerodynamic Analysis of Wing-Body-Tail Configurations in Subsonic and Supersonic Flow. Part 1 - Theory and Application. NASA CR-2228, Part 1, May 1973.

10. Woodward, F. A.: An Improved Method for the Aerodynamic Analysis of Wing-Body-Tail Configurations in Subsonic and Supersonic Flow. Part II - Computer Program Description. NASA CR-2228, Part II, May 1973.

11. Graves, E. B.: Aerodynamic Characteristics of a Monoplanar Missile Concept with Bodies of Circular and Elliptical Cross Sections. NASA Technical Memorandum 74079, Dec. 1977.

12. Perkins, S. C., Jr., Goodwin, F. K.: Data Report for an External Store Test Program Conducted at Supersonic Speeds. Vol. V - Mach Number 1.5 Pressure Distribution Data. NEAR TR 103, Dec. 1975.

13. Perkins, S. C., Jr., Goodwin, F. K.: Data Report for an External Store Test Program Conducted at Supersonic Speeds. Vol. VI - Mach Number 2.0 Pressure Distribution Data. NEAR TR 103, Dec. 1975.

14. Perkins, S. C., Jr., Goodwin, F. K.: Data Report for an External Store Test Program Conducted at Supersonic Speeds. Vol. VII - Mach Number 2.5 Pressure Distribution Data. NEAR TR 103, Dec. 1975.

15. Nielsen, J. N., Spangler, S. B., Hemsch, M. J.: A Study of Induced Rolling Moments for Cruciform-Winged Missiles. NEAR TR 61, Dec. 1973. Work performed for Naval Weapons Center, China Lake, CA, under Hughes Aircraft Subcontract K4-570727-WA6.

16. Margolis, K.: Theoretical Calculations of the Lateral Force and Yawing Moment due to Rolling at Supersonic Speeds for Swept Back Tapered Wings with Streamline Tips, Subsonic Leading Edges. NACA TN 2122, June 1950.

17. Cohen, D.: Formulas for the Supersonic Loading, Lift and Drag of Flat Swept-back Wings, with Leading Edges behind the Mach Lines. NACA Report 1050, 1951.

18. Lamar, John E.: Prediction of Vortex Flow Characteristics of Wings at Subsonic and Supersonic Speeds. J. of Aircraft, Vol. 13, No. 7, July 1976.

19. Peirce, B. O.: A Short Table of Integrals. Rev. by R. M. Foster, 4th ed., Boston, Ginn, 1956.

20. Gröbner, W. and Hofreiter, N.: Integraltafel. Springer-Verlag, 1961.

21. Adams, Gaynor J. and Dugan, Duane W.: Theoretical Damping in Roll and Rolling Moment Due to Differential Wing Incidence For Slender Cruciform Wing and Wing-Body Combinations. NACA TR 1088, 1952.

22. Bryson, Arthur E., Jr.: Evaluation of Inertia Coefficients of the Cross Section of a Slender Body. Jour. of Aero. Sci., Vol. 21, No. 6, June 1954, pp. 424-427.

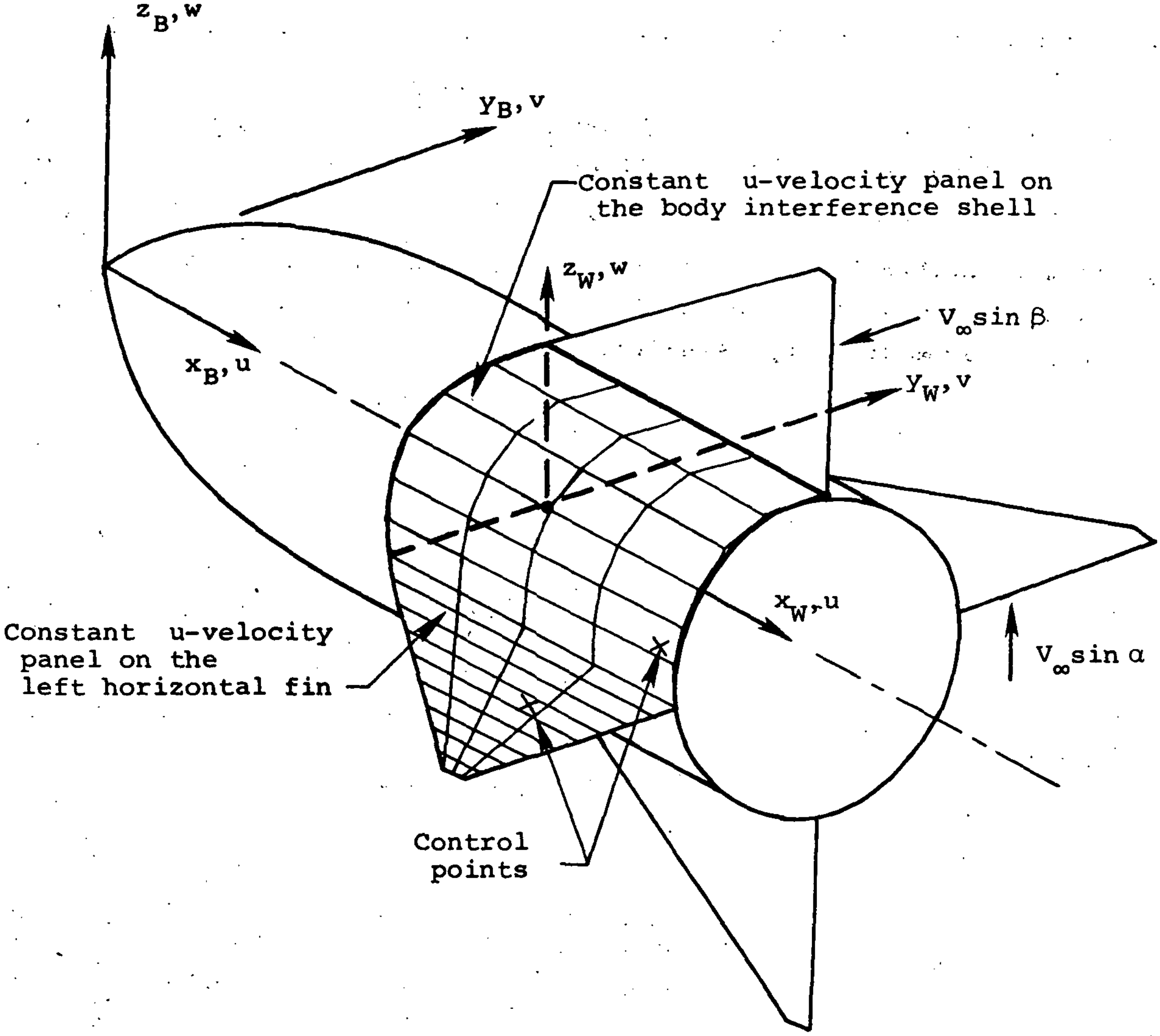


Figure 1.- Coordinate systems and typical panel layout shown for one fin and quarter of the interference shell.

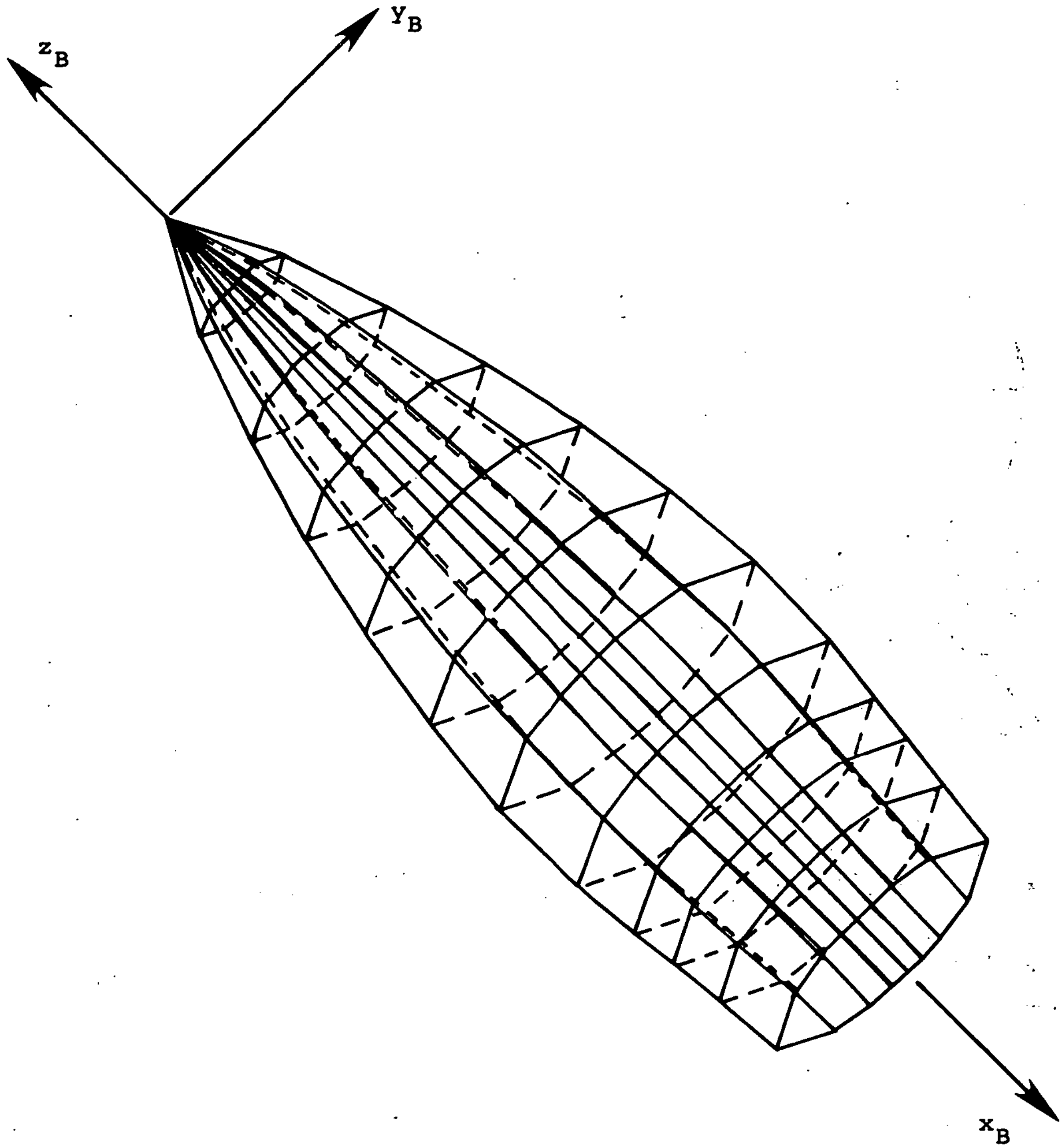
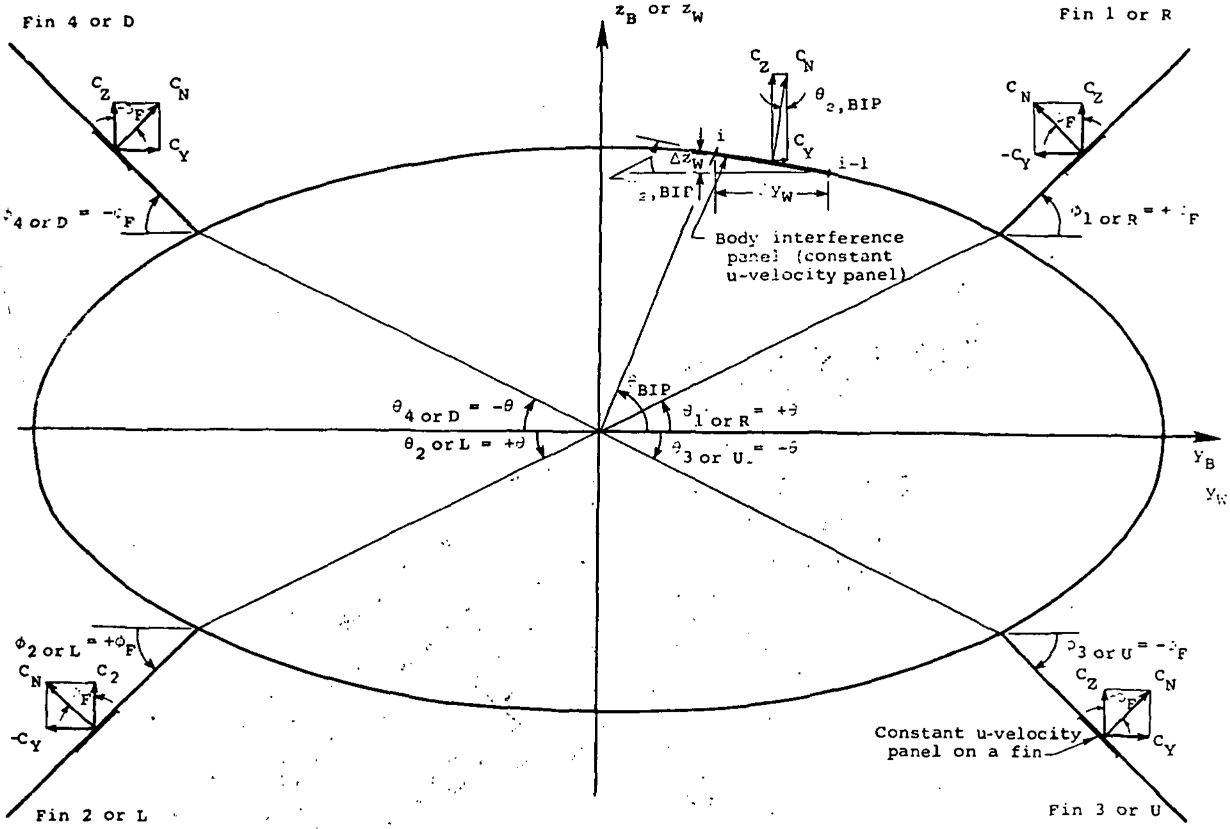


Figure 2.- Isometric view of typical layout of body source panels on the surface of a body with elliptical cross section, 11 rings with 16 panels each.



ϕ_F = fin dihedral angle, PHIDIH

$\phi_{1 \text{ or } R}$ = dihedral angle of right upper fin, PHIFR=PHIDIH

$\phi_{2 \text{ or } L}$ = dihedral angle of left lower fin, PHIFL=PHIDIH

$\phi_{3 \text{ or } U}$ = dihedral angle of right lower fin, PHIFU= -PHIDIH

$\phi_{4 \text{ or } D}$ = dihedral angle of left upper fin, PHIFD= -PHIDIH

θ = fin location polar angle, THETIT

$\theta_{1 \text{ or } R}$ = polar angle of right upper fin, THETR=THETIT

$\theta_{2 \text{ or } L}$ = polar angle of left lower fin, THETL=THETIT

$\theta_{3 \text{ or } U}$ = polar angle of right lower fin, THETI= -THETIT

$\theta_{4 \text{ or } D}$ = polar angle of left upper fin, THETD= -THETIT

Body interference panels:

$\theta_{BIP,j}$ = THTI(J), $\Delta z_W = z_{W,i} - z_{W,i-1}$

$\Delta y_W = y_{W,i} - y_{W,i-1}$

$$\left.\begin{aligned} \sin \theta_{2,BIP} &= \frac{\Delta z_W}{\sqrt{\Delta z_W^2 + \Delta y_W^2}} \\ \cos \theta_{2,BIP} &= \frac{-\Delta y_W}{\sqrt{\Delta z_W^2 + \Delta y_W^2}} \end{aligned}\right\}$$

these functions are used in the transformation (rotation) of the body interference panel to the reference (x_B, y_B, z_B) or (x_W, y_W, z_W) system

Figure 3.- Geometrical angles associated with case involving interdigitated tails on body with elliptical cross section as required by program DEMON2. Force coefficients associated with fins and body interference panel.

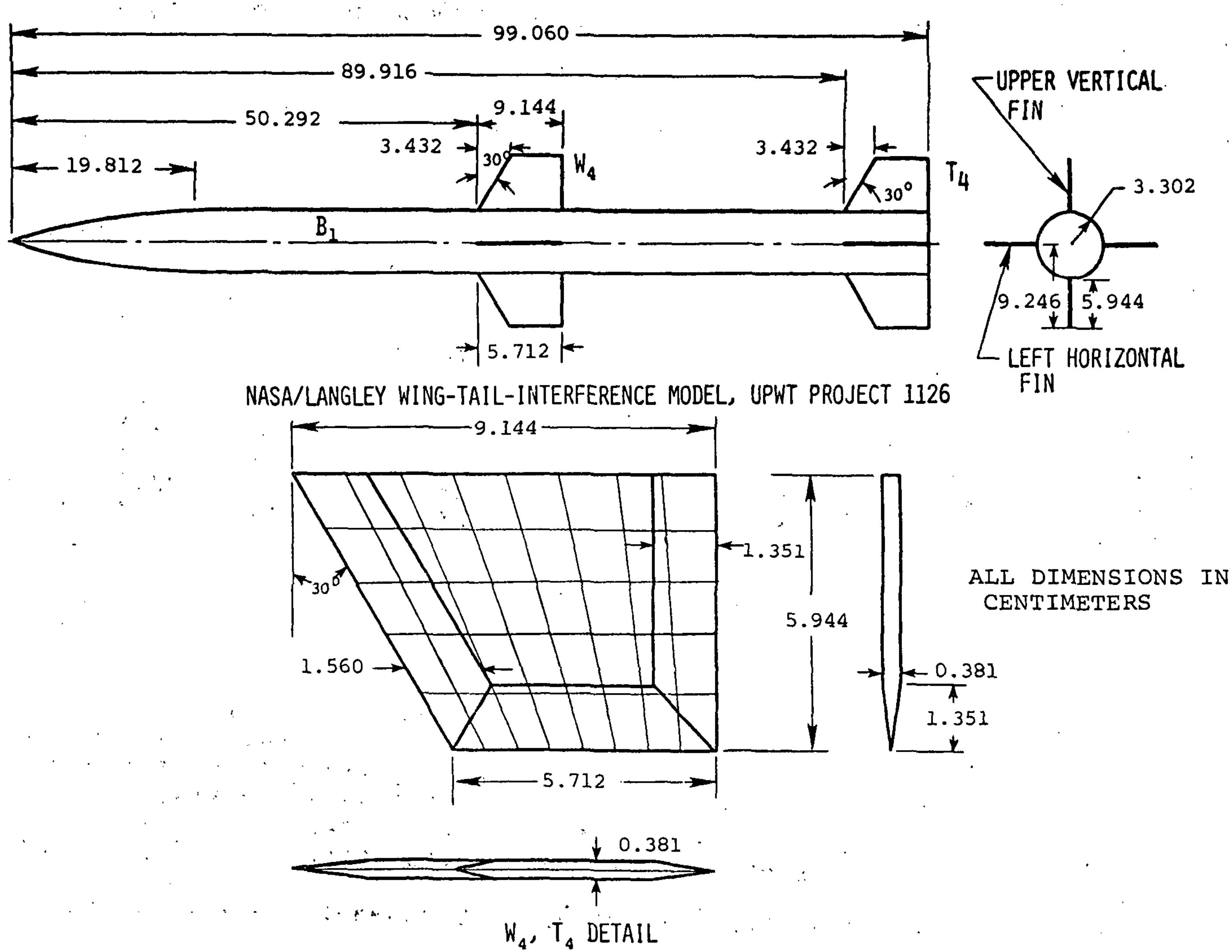


Figure 4.- Configuration used for first calculation example.

```
NASA/LANGLEY WING-TAIL INTERFERENCE MODEL,UPWT PROJ.1126,CONFIGURATION B1W4,
$INPUT
CRP=3.6,SWLEP=30.0,B2=2.34,SWLEV=30.0,CRPV=3.6,B2V=2.34,
NCW=3,MSWR=5,MSWL=5,MSWU=5,MSWD=5,NCRX=1,
ALFAC=14.216,PHI=45.0,FMACH=1.7,
RB=1.3,NBDCR=16,NCWB=3,BIL=3.6,XWLE=19.8,
SREF=5.30929,REFL=2.69,
NOLINP=1,NOUT=0,NDRAG=1,NBDYPR=1,
VRTMAX=0.5,
NCPOUT=1,
NTDAT=1,NCWT=8,
XM=19.5,ZM=0.0,
$END
   5      0      0
 0.122      0.0        0.0        0.0        0.0        0.0        0.0       -0.141
 0.122      0.122      0.0        0.0        0.0        0.0        0.0       -0.141
 0.122      0.122      0.0        0.0        0.0        0.0        0.0       -0.141
 0.122      0.122      0.0        0.0        0.0        0.0       -0.141     -0.141
 0.122      0.0        0.0        0.0        0.0        0.0        0.0       -0.141
$BODY
NXBODY=39,LNOSE=7.8,LBODY=39.0,BCODE=2,
$END
         0          0          0          0
         0
ZZZZZZZZZZ
```

Figure 5.- Input for program DEMON2, first sample case, step 16.

```
NASA/LANGLEY WING-TAIL INTERFERENCE MODEL,UPWT PROJ.1126,CONFIGURATION B1W4.
$INPUT
                                                              SREF    = .530929E+01,
CRP     = .36E+01,                                            REFL    = .269E+01,
SWLEP   = .3E+02,                                             PHIDTH  = 0.0,
SWTEP   = 0.0,                                                THETIT  = 0.0,
NCW     = 3,                                                  XWLE    = .198E+02,
MSWR    = 5,                                                  NOLINP  = 1,
MSWL    = 5,                                                  NOUT    = 0,
ALFAC   = .14216E+02,                                         NPR     = 0,
PHI     = .45E+02,                                            NDRAG   = 1,
B2      = .234E+01,                                           NVRTX   = 0,
FMACH   = .17E+01,                                            NPRESS  = 0,
LVSWP   = 0,                                                  VRTMAX  = .5E+00,
FAC     = .95E+00,                                            NCWR    = 3,
NFVNPR  = 0,                                                  NAGAIN  = 0,
TOLFAC  = .1E+01,                                             BIL     = .36E+01,
MSWU    = 5,                                                  ITATI   = 0,
MSWD    = 5,                                                  NVRTPL  = 0,
SWLEV   = .3E+02,                                             NBDYPR  = 1,
SWTEV   = 0.0,                                                NTPR    = 0,
CRPV    = .36E+01,                                            NTDAT   = 1,
B2V     = .234E+01,                                           NCWT    = 8,
NCRX    = 1,                                                  NCPOUT  = 1,
RB      = .13E+01,                                            NVLTU   = 0,
RA      = .13E+01,                                            XSTART  = 0.0,
ZRATIO  = .1E+01,                                             JCPT    = 0,
NHDCR   = 16,                                                 FKLE    = .5E+00,
DELR    = 0.0,                                                FKSE    = .5E+00,
DELL    = 0.0,                                                XM      = .195E+02,
DELU    = 0.0,                                                ZM      = 0.0,
DELD    = 0.0,                                                $END
```

Figure 6.- Output of program DEMON2, first sample case, step 1b.

WING GEOMETRY

TIP CHORD = 2.24900

ROOT CHORD = 3.60000

WING SEMISPAN = 2.34000

LEADING EDGE SWEEP = 30.00000 DEGREES

TRAILING EDGE SWEEP = 0.00000 DEGREES

FLOW CONDITIONS

MACH = 1.70000 ALPHAC= 14.21600 PHI = 45.00000 ALFA = 10.00010 BETA = 10.00010

CRPT = 3.60000
CRPTV = 3.60000
WING THICKNESS INPUT DATA

SPANWISE LOCATIONS OF PANEL SIDE EDGES AND SWEEP ANGLES
OF WING SECTION TO THE LEFT

I	SPANWISE LOCATION FEET	LE SWEEP DEGREES	TE SWEEP DEGREES

RIGHT WING SURFACE

1	1.30000	0.00000	0.00000
2	1.76800	30.00000	0.00000
3	2.23600	30.00000	0.00000
4	2.70400	30.00000	0.00000
5	3.17200	30.00000	0.00000
6	3.64000	30.00000	0.00000

40 THICKNESS PANELS ARE TO BE LAID OUT
5 CHORDWISE ROWS WITH 8 IN EACH ROW

UPPER WING SURFACE

1	1.30000	0.00000	0.00000
2	1.76800	30.00000	0.00000
3	2.23600	30.00000	0.00000
4	2.70400	30.00000	0.00000
5	3.17200	30.00000	0.00000
6	3.64000	30.00000	0.00000

40 THICKNESS PANELS ARE TO BE LAID OUT
5 CHORDWISE ROWS WITH 8 IN EACH ROW

Figure 6.- Continued.

INPUT VALUES OF THE LOCAL SURFACE SLOPE OF THE THICKNESS
DISTRIBUTION, FOR EACH CHORDWISE ROW THE FIRST VALUE
IS FOR THE PANEL NEAREST THE LEADING EDGE

RIGHT WING SURFACE

ROW	SLOPES							
1	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
2	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
3	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
4	.12200	.12200	0.00000	0.00000	0.00000	0.00000	-.14100	-.14100
5	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100

UPPER WING SURFACE

ROW	SLOPES							
1	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
2	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
3	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
4	.12200	.12200	0.00000	0.00000	0.00000	0.00000	-.14100	-.14100
5	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100

CONTROL POINTS WRITTEN ON TAPE4

I	XCPT	YCPT	ZCPT
1	1.2311	1.5310	0.
2	2.3867	1.5310	0.
3	3.5422	1.5310	0.
4	1.4157	1.9987	0.
5	2.4812	1.9987	0.
6	3.5467	1.9987	0.
7	1.6002	2.4664	0.
8	2.5757	2.4664	0.
9	3.5512	2.4664	0.
10	1.7847	2.9340	0.
11	2.6702	2.9340	0.
12	3.5557	2.9340	0.
13	1.9691	3.4016	0.
14	2.7647	3.4016	0.
15	3.5602	3.4016	0.
16	1.2311	-1.5310	0.
17	2.3867	-1.5310	0.
18	3.5422	-1.5310	0.
19	1.4157	-1.9987	0.
20	2.4812	-1.9987	0.
21	3.5467	-1.9987	0.
22	1.6002	-2.4664	0.
23	2.5757	-2.4664	0.
24	3.5512	-2.4664	0.
25	1.7847	-2.9340	0.
26	2.6702	-2.9340	0.
27	3.5557	-2.9340	0.
28	1.9691	-3.4016	0.
29	2.7647	-3.4016	0.
30	3.5602	-3.4016	0.
31	1.2311	0.	1.5310
32	2.3867	0.	1.5310

Figure 6.- Continued.

33	3.5422	0.	1.5310
34	1.4157	0.	1.9987
35	2.4812	0.	1.9987
36	3.5467	0.	1.9987
37	1.6002	0.	2.4664
38	2.5757	0.	2.4664
39	3.5512	0.	2.4664
40	1.7847	0.	2.9340
41	2.6702	0.	2.9340
42	3.5557	0.	2.9340
43	1.9691	0.	3.4016
44	2.7647	0.	3.4016
45	3.5602	0.	3.4016
46	1.2311	0.	-1.5310
47	2.3967	0.	-1.5310
48	3.5422	0.	-1.5310
49	1.4157	0.	-1.9987
50	2.4812	0.	-1.9987
51	3.5467	0.	-1.9987
52	1.6002	0.	-2.4664
53	2.5757	0.	-2.4664
54	3.5512	0.	-2.4664
55	1.7847	0.	-2.9340
56	2.6702	0.	-2.9340
57	3.5557	0.	-2.9340
58	1.9691	0.	-3.4016
59	2.7647	0.	-3.4016
60	3.5602	0.	-3.4016
61	1.1400	1.2505	.24874
62	1.1400	1.0601	.70836
63	1.1400	.70836	1.0601
64	1.1400	.24874	1.2505
65	1.1400	-.24874	1.2505
66	1.1400	-.70836	1.0601
67	1.1400	-1.0601	.70836
68	1.1400	-1.2505	.24874
69	1.1400	-1.2505	-.24874
70	1.1400	-1.0601	-.70836
71	1.1400	-.70836	-1.0601
72	1.1400	-.24874	-1.2505
73	1.1400	.24874	-1.2505
74	1.1400	.70836	-1.0601
75	1.1400	1.0601	-.70836
76	1.1400	1.2505	-.24874
77	2.3400	1.2505	.24874
78	2.3400	1.0601	.70836
79	2.3400	.70836	1.0601
80	2.3400	.24874	1.2505
81	2.3400	-.24874	1.2505
82	2.3400	-.70836	1.0601
83	2.3400	-1.0601	.70836
84	2.3400	-1.2505	.24874
85	2.3400	-1.2505	-.24874
86	2.3400	-1.0601	-.70836
87	2.3400	-.70836	-1.0601
88	2.3400	-.24874	-1.2505
89	2.3400	.24874	-1.2505
90	2.3400	.70836	-1.0601
91	2.3400	1.0601	-.70836
92	2.3400	1.2505	-.24874
93	3.5400	1.2505	.24874
94	3.5400	1.0601	.70836
95	3.5400	.70836	1.0601
96	3.5400	.24874	1.2505
97	3.5400	-.24874	1.2505
98	3.5400	-.70836	1.0601
99	3.5400	-1.0601	.70836
100	3.5400	-1.2505	.24874
101	3.5400	-1.2505	-.24874
102	3.5400	-1.0601	-.70836
103	3.5400	-.70836	-1.0601
104	3.5400	-.24874	-1.2505
105	3.5400	.24874	-1.2505
106	3.5400	.70836	-1.0601
107	3.5400	1.0601	-.70836
108	3.5400	1.2505	-.24874

```
$BODY

NXBODY  = 39,

LNOSE   = .78E+01,

LBODY   = .39E+02,

BCODE   = 2,

$END
```

Figure 6.- Continued.

PHYSICAL DIMENSIONS OF BODY AND LINE SINGULARITY STRENGTHS REPRESENTING THE BODY AT MACH= 1.7000 ALFAC= 14.2160

	X	R	DR/DX	TX	T(I)	TC(I)
1	0.0000	-.42633E-13	.34286	.58610E-13	.10092	.39463E-01
2	1.0263	.32639	.29353	.57761	-.44121E-01	-.10955E-01
3	2.0526	.60316	.24611	1.2234	-.25012E-01	-.62846E-02
4	3.0789	.83207	.20020	1.9350	-.23274E-01	-.81381E-02
5	4.1053	1.0145	.15547	2.7106	-.18881E-01	-.74517E-02
6	5.1316	1.1515	.11164	3.5485	-.15477E-01	-.75496E-02
7	6.1579	1.2439	.68439E-01	4.4479	-.11952E-01	-.73645E-02
8	7.1842	1.2921	.25613E-01	5.4078	-.83169E-02	-.70718E-02
9	8.2105	1.3000	0.	6.4233	.31078E-01	-.28112E-02
10	9.2368	1.3000	0.	7.4496	.35293E-02	.47755E-02
11	10.2632	1.3000	0.	8.4760	.34046E-02	.39930E-02
12	11.2895	1.3000	0.	9.5023	.14132E-02	.36673E-02
13	12.3158	1.3000	0.	10.529	.93969E-03	.26432E-02
14	13.3421	1.3000	0.	11.555	.55466E-03	.17866E-02
15	14.3684	1.3000	0.	12.581	.36257E-03	.10708E-02
16	15.3947	1.3000	0.	13.608	.23850E-03	.56355E-03
17	16.4211	1.3000	0.	14.634	.16227E-03	.22980E-03
18	17.4474	1.3000	0.	15.660	.11249E-03	.33410E-04
19	18.4737	1.3000	0.	16.686	.79559E-04	-.67235E-04
20	19.5000	1.3000	0.	17.713	.57218E-04	-.10629E-03
21	20.5263	1.3000	0.	18.739	.41794E-04	-.10983E-03
22	21.5526	1.3000	0.	19.765	.30961E-04	-.95708E-04
23	22.5789	1.3000	0.	20.792	.23236E-04	-.75192E-04
24	23.6053	1.3000	0.	21.818	.17650E-04	-.54633E-04
25	24.6316	1.3000	0.	22.844	.13558E-04	-.37078E-04
26	25.6579	1.3000	0.	23.871	.10525E-04	-.23532E-04
27	26.6842	1.3000	0.	24.897	.82509E-05	-.13875E-04
28	27.7105	1.3000	0.	25.923	.65280E-05	-.74713E-05
29	28.7368	1.3000	0.	26.950	.52100E-05	-.35327E-05
30	29.7632	1.3000	0.	27.976	.41922E-05	-.13202E-05
31	30.7895	1.3000	0.	29.002	.33993E-05	-.22844E-06
32	31.8158	1.3000	0.	30.029	.27766E-05	.19378E-06
33	32.8421	1.3000	0.	31.055	.22835E-05	.25675E-06
34	33.8684	1.3000	0.	32.081	.18903E-05	.15784E-06
35	34.8947	1.3000	0.	33.108	.15745E-05	.11691E-07
36	35.9211	1.3000	0.	34.134	.13191E-05	-.12295E-06
37	36.9474	1.3000	0.	35.160	.11112E-05	-.22221E-06
38	37.9737	1.3000	0.	36.186	.94102E-06	-.28186E-06
39	39.0000	1.3000	0.	37.213	0.	0.

PRESSURE COEFFICIENTS AT POINTS ON BODY MERIDIANS

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.
TOTAL NUMBER OF PRESSURE POINTS,JCPT= 320												
BODY RING= 1												
1	11.25000	.51316	.16626	.03307	-.20308	.36619	.16431	.40615	.31470	.31793	1.63664	1.82164
2	22.50000	.51316	.15662	.06487	-.18664	.28906	.22763	.34935	.24369	.31793	1.49299	1.74720

Figure 6.- Continued.

3	33.75000	.51316	.14095	.09418	-.16471	.20227	.26242	.32942	.18128	.31793	1.36673	1.66642
4	45.00000	.51316	.11987	.11987	-.14395	.11616	.26874	.28789	.13035	.31793	1.26371	1.58241
5	56.25000	.51316	.09418	.14095	-.12318	.04000	.25033	.24637	.09186	.31793	1.18583	1.49840
6	67.50000	.51316	.06487	.15662	-.10322	-.01932	.21384	.20644	.06525	.31793	1.13200	1.41762
7	78.75000	.51316	.03307	.16626	-.08482	-.05811	.16768	.16964	.04898	.31793	1.09908	1.34318
8	90.00000	.51316	-.00000	.16952	-.06869	-.07629	.12065	.13738	.04083	.31793	1.08261	1.27792
9	101.25000	.51316	-.03307	.16626	-.05545	-.07713	.08050	.11091	.03828	.31793	1.07744	1.22437
10	112.50000	.51316	-.06487	.15662	-.04562	-.06654	.05275	.09124	.03876	.31793	1.07842	1.18458
11	123.75000	.51316	-.09418	.14095	-.03956	-.05195	.03986	.07913	.04007	.31793	1.08107	1.16007
12	135.00000	.51316	-.11987	.11987	-.03752	-.04093	.04093	.07504	.04069	.31793	1.08232	1.15180
13	146.25000	.51316	-.14095	.09418	-.03956	-.03986	.05195	.07913	.04007	.31793	1.08107	1.16007
14	157.50000	.51316	-.15662	.06487	-.04562	-.05275	.06654	.09124	.03876	.31793	1.07842	1.18458
15	168.75000	.51316	-.16626	.03307	-.05545	-.08050	.07713	.11091	.03828	.31793	1.07744	1.22437
16	180.00000	.51316	-.16952	-.00000	-.06869	-.12065	.07629	.13738	.04083	.31793	1.08261	1.27792
17	191.25000	.51316	-.16626	-.03307	-.08482	-.16768	.05811	.16964	.04898	.31793	1.09908	1.34318
18	202.50000	.51316	-.15662	-.06487	-.10322	-.21384	.01932	.20644	.06525	.31793	1.13200	1.41762
19	213.75000	.51316	-.14095	-.09418	-.12318	-.25033	-.04000	.24637	.09186	.31793	1.18583	1.49840
20	225.00000	.51316	-.11987	-.11987	-.14395	-.26874	-.11616	.28789	.13035	.31793	1.26371	1.58241
21	236.25000	.51316	-.09418	-.14095	-.16471	-.26242	-.20227	.32942	.18128	.31793	1.36673	1.66642
22	247.50000	.51316	-.06487	-.15662	-.18468	-.22763	-.28906	.36935	.24369	.31793	1.49299	1.74720
23	258.75000	.51316	-.03307	-.16626	-.20308	-.16431	-.36619	.40615	.31470	.31793	1.63664	1.82164
24	270.00000	.51316	.00000	-.16952	-.21920	-.07629	-.42368	.43841	.38919	.31793	1.78734	1.88690
25	281.25000	.51316	.03307	-.16626	-.23244	.02907	-.45337	.46488	.46006	.31793	1.93070	1.94045
26	292.50000	.51316	.06487	-.15662	-.24227	.14177	-.45015	.48455	.51904	.31793	2.05002	1.98024
27	303.75000	.51316	.09418	-.14095	-.24833	.25047	-.41274	.49666	.55827	.31793	2.12939	2.00475
28	315.00000	.51316	.11987	-.11987	-.25038	.34397	-.34397	.50075	.57205	.31793	2.15725	2.01302
29	326.25000	.51316	.14095	-.09418	-.24833	.41274	-.25047	.49666	.55827	.31793	2.12939	2.00475
30	337.50000	.51316	.15662	-.06487	-.24227	.45015	-.14177	.48455	.51904	.31793	2.05002	1.98024
31	348.75000	.51316	.16626	-.03307	-.23244	.45337	-.02907	.46488	.46006	.31793	1.93070	1.94045
32	360.00000	.51316	.16952	.00000	-.21920	.42368	.07629	.43841	.38919	.31793	1.78734	1.88690

BODY RINGS 2

1	11.25000	2.56579	.70961	.14115	-.14124	.29958	.18203	.28247	.19422	.22298	1.39291	1.57144
2	22.50000	2.56579	.66843	.27687	-.12479	.21696	.23429	.24959	.12886	.22298	1.26069	1.50491
3	33.75000	2.56579	.60157	.40196	-.10695	.12713	.25530	.21390	.07368	.22298	1.14905	1.43273
4	45.00000	2.56579	.51160	.51160	-.08840	.04161	.24586	.17679	.03113	.22298	1.06297	1.35766
5	56.25000	2.56579	.40196	.60157	-.06984	-.02944	.21090	.13969	.00171	.22298	1.00347	1.28258
6	67.50000	2.56579	.27687	.66843	-.05200	-.07871	.15864	.10400	-.01550	.22298	.96864	1.21040
7	78.75000	2.56579	.14115	.70961	-.03556	-.10271	.09915	.07112	-.02244	.22298	.95460	1.14387
8	90.00000	2.56579	-.00000	.72351	-.02115	-.10212	.04282	.04229	-.02170	.22298	.95609	1.08556
9	101.25000	2.56579	-.14115	.70961	-.00932	-.08155	-.00133	.01864	-.01635	.22298	.96695	1.03770
10	112.50000	2.56579	-.27687	.66843	-.00053	-.04863	-.02703	.00106	-.00950	.22298	.98077	1.00214
11	123.75000	2.56579	-.40196	.60157	.00486	-.01272	-.03168	-.00977	-.00406	.22298	.99179	.98024
12	135.00000	2.56579	-.51160	.51160	.00671	.01671	-.01671	-.01342	-.00200	.22298	.99595	.97285
13	146.25000	2.56579	-.60157	.40196	.00488	.03168	.01272	-.00977	-.00406	.22298	.99179	.98024
14	157.50000	2.56579	-.66843	.27687	-.00053	.02703	.04863	.00106	-.00950	.22298	.98077	1.00214
15	168.75000	2.56579	-.70961	.14115	-.00932	.00133	.08155	.01864	-.01635	.22298	.96695	1.03770
16	180.00000	2.56579	-.72351	-.00000	-.02115	-.04282	.10212	.04229	-.02170	.22298	.95609	1.08556
17	191.25000	2.56579	-.70961	-.14115	-.03556	-.09915	.10271	.07112	-.02244	.22298	.95460	1.14387
18	202.50000	2.56579	-.66843	-.27687	-.05200	-.15864	.07871	.10400	-.01550	.22298	.96864	1.21040
19	213.75000	2.56579	-.60157	-.40196	-.06984	-.21090	.02944	.13969	.00171	.22298	1.00347	1.28258
20	225.00000	2.56579	-.51160	-.51160	-.08840	-.24586	-.04161	.17679	.03113	.22298	1.06297	1.35766
21	236.25000	2.56579	-.40196	-.60157	-.10695	-.25530	-.12713	.21390	.07368	.22298	1.14905	1.43273
22	247.50000	2.56579	-.27687	-.66843	-.12479	-.23429	-.21696	.24959	.12886	.22298	1.26069	1.50491
23	258.75000	2.56579	-.14115	-.70961	-.14124	-.18203	-.29958	.28247	.19422	.22298	1.39291	1.57144

Figure 6.- Continued.

24	270.00000	2.56579	.00000	-.72351	-.15565	-.10212	-.36372	.31130	.26490	.22298	1.53589	1.62975
25	281.25000	2.56579	.14115	-.70961	-.16748	-.00223	-.40006	.33495	.33372	.22298	1.67511	1.67761
26	292.50000	2.56579	.27687	-.66843	-.17627	.10695	-.40263	.35253	.39199	.22298	1.79299	1.71317
27	303.75000	2.56579	.40196	-.60157	-.18168	.21315	-.36971	.36335	.43119	.22298	1.87230	1.73507
28	315.00000	2.56579	.51160	-.51160	-.18350	.30418	-.30418	.36701	.44503	.22298	1.90030	1.74246
29	326.25000	2.56579	.60157	-.40196	-.18168	.36971	-.21315	.36335	.43119	.22298	1.87230	1.73507
30	337.50000	2.56579	.66843	-.27687	-.17627	.40263	-.10695	.35253	.39199	.22298	1.79299	1.71317
31	348.75000	2.56579	.70961	-.14115	-.16748	.40006	.00223	.33495	.33372	.22298	1.67511	1.67761
32	360.00000	2.56579	.72351	.00000	-.15565	.36372	.10212	.31130	.26490	.22298	1.53589	1.62975

BODY RINGS 3

1	11.25000	4.61842	1.06771	.21238	-.08033	.22574	.20086	.16066	.06989	.13346	1.14139	1.32501
2	22.50000	4.61842	1.00576	.41660	-.06680	.13775	.24102	.13359	.01221	.13346	1.02471	1.27026
3	33.75000	4.61842	.90516	.60481	-.05211	.04519	.24720	.10423	-.03411	.13346	.93100	1.21085
4	45.00000	4.61842	.76977	.76977	-.03684	-.03919	.22098	.07369	-.06712	.13346	.86423	1.14907
5	56.25000	4.61842	.60481	.90516	-.02157	-.10436	.16857	.04315	-.08669	.13346	.82463	1.08729
6	67.50000	4.61842	.41660	1.00576	-.00689	-.14264	.09977	.01378	-.09400	.13346	.80985	1.02788
7	78.75000	4.61842	.21238	1.06771	.00664	-.15070	.02641	-.01328	-.09112	.13346	.81567	.97313
8	90.00000	4.61842	-.00000	1.08863	.01850	-.13008	-.03951	-.03701	-.08092	.13346	.83630	.92514
9	101.25000	4.61842	-.21238	1.06771	.02824	-.08677	-.08768	-.05647	-.06693	.13346	.86461	.88575
10	112.50000	4.61842	-.41660	1.00576	.03547	-.03020	-.11104	-.07094	-.05303	.13346	.89273	.85649
11	123.75000	4.61842	-.60481	.90516	.03992	.02825	-.10687	-.07985	-.04289	.13346	.91324	.83847
12	135.00000	4.61842	-.76977	.76977	.04143	.07716	-.07716	-.08286	-.03916	.13346	.92073	.83238
13	146.25000	4.61842	-.90516	.60481	.03992	.10687	-.02825	-.07985	-.04289	.13346	.91324	.83847
14	157.50000	4.61842	-1.00576	.41660	.03547	.11104	.03020	-.07094	-.05303	.13346	.89273	.85649
15	168.75000	4.61842	-1.06771	.21238	.02824	.08768	.08677	-.05647	-.06693	.13346	.86461	.88575
16	180.00000	4.61842	-1.08863	-.00000	.01850	.03951	.13008	-.03701	-.08092	.13346	.83630	.92514
17	191.25000	4.61842	-1.06771	-.21238	.00664	-.02641	.15070	-.01328	-.09112	.13346	.81567	.97313
18	202.50000	4.61842	-1.00576	-.41660	-.00689	-.09977	.14264	.01378	-.09400	.13346	.80985	1.02788
19	213.75000	4.61842	-.90516	-.60481	-.02157	-.16857	.10436	.04315	-.08669	.13346	.82463	1.08729
20	225.00000	4.61842	-.76977	-.76977	-.03684	-.22098	.03919	.07369	-.06712	.13346	.86423	1.14907
21	236.25000	4.61842	-.60481	-.90516	-.05211	-.24720	-.04519	.10423	-.03411	.13346	.93100	1.21085
22	247.50000	4.61842	-.41660	-1.00576	-.06680	-.24102	-.13775	.13359	.01221	.13346	1.02471	1.27026
23	258.75000	4.61842	-.21238	-1.06771	-.08033	-.20086	-.22574	.16066	.06989	.13346	1.14139	1.32501
24	270.00000	4.61842	.00000	-1.08863	-.09219	-.13008	-.29660	.18438	.13453	.13346	1.27215	1.37300
25	281.25000	4.61842	.21238	-1.06771	-.10192	-.03661	-.33983	.20385	.19915	.13346	1.40288	1.41238
26	292.50000	4.61842	.41660	-1.00576	-.10916	.06818	-.34857	.21831	.25494	.13346	1.51574	1.44164
27	303.75000	4.61842	.60481	-.90516	-.11361	.17108	-.32064	.22722	.29296	.13346	1.59265	1.45967
28	315.00000	4.61842	.76977	-.76977	-.11511	.25895	-.25895	.23023	.30647	.13346	1.61998	1.46575
29	326.25000	4.61842	.90516	-.60481	-.11361	.32064	-.17108	.22722	.29296	.13346	1.59265	1.45967
30	337.50000	4.61842	1.00576	-.41660	-.10916	.34857	-.06818	.21831	.25494	.13346	1.51574	1.44164
31	348.75000	4.61842	1.06771	-.21238	-.10192	.33983	.03661	.20385	.19915	.13346	1.40288	1.41238
32	360.00000	4.61842	1.08863	.00000	-.09219	.29660	.13008	.18438	.13453	.13346	1.27215	1.37300

BODY RINGS 4

1	11.25000	6.67105	1.24902	.24845	-.01697	.14328	.22303	.03394	-.06233	.04699	.87392	1.06867
2	22.50000	6.67105	1.17655	.48734	-.00804	.04966	.25004	.01608	-.10916	.04699	.77918	1.03254
3	33.75000	6.67105	1.05887	.70751	.00165	-.04565	.24017	-.00329	-.14409	.04699	.70850	.99334
4	45.00000	6.67105	.90049	.90049	.01172	-.12864	.19587	-.02345	-.16569	.04699	.66481	.95257
5	56.25000	6.67105	.70751	1.05887	.02180	-.18734	.12471	-.04360	-.17404	.04699	.64791	.91180
6	67.50000	6.67105	.48734	1.17655	.03149	-.21365	.03819	-.06298	-.17024	.04699	.65560	.87260
7	78.75000	6.67105	.24845	1.24902	.04042	-.20448	-.05002	-.08084	-.15623	.04699	.68394	.83647
8	90.00000	6.67105	-.00000	1.27349	.04825	-.16226	-.12618	-.09649	-.13495	.04699	.72699	.80480

Figure 6.- Continued.

9	101.25000	6.67105	-.24845	1.24902	.05467	-.09446	-.17860	-.10934	-.11043	.04699	.77659	.77841
10	112.50000	6.67105	-.48734	1.17655	.05944	-.01246	-.19939	-.11888	-.08758	.04699	.82282	.75950
11	123.75000	6.67105	-.70751	1.05887	.06238	.07024	-.18570	-.12476	-.07135	.04699	.85566	.74761
12	135.00000	6.67105	-.90049	.90049	.06337	.14011	-.14011	-.12675	-.06547	.04699	.86756	.74359
13	146.25000	6.67105	-1.05887	.70751	.06238	.18570	-.07024	-.12476	-.07135	.04699	.85566	.74761
14	157.50000	6.67105	-1.17655	.48734	.05944	.19939	.01246	-.11888	-.08758	.04699	.82282	.75950
15	168.75000	6.67105	-1.24902	.24845	.05467	.17860	.09446	-.10934	-.11003	.04699	.77659	.77881
16	180.00000	6.67105	-1.27349	-.00000	.04825	.12618	.16226	-.09649	-.13495	.04699	.72699	.80480
17	191.25000	6.67105	-1.24902	-.24845	.04042	.05002	.20448	-.08084	-.15623	.04699	.68394	.83647
18	202.50000	6.67105	-1.17655	-.48734	.03149	-.03819	.21365	-.06298	-.17024	.04699	.65560	.87260
19	213.75000	6.67105	-1.05887	-.70751	.02180	-.12471	.18734	-.04360	-.17404	.04699	.64791	.91180
20	225.00000	6.67105	-.90049	-.90049	.01172	-.19527	.12864	-.02345	-.16569	.04699	.66481	.95257
21	236.25000	6.67105	-.70751	-1.05887	.00165	-.24017	.04565	-.00329	-.14409	.04699	.70850	.99334
22	247.50000	6.67105	-.48734	-1.17655	-.00804	-.25004	-.04966	.01608	-.10916	.04699	.77918	1.03254
23	258.75000	6.67105	-.24845	-1.24902	-.01697	-.22303	-.14328	.03394	-.06233	.04699	.87392	1.06867
24	270.00000	6.67105	.00000	-1.27349	-.02480	-.16226	-.22127	.04960	-.00729	.04699	.98525	1.10034
25	281.25000	6.67105	.24845	-1.24902	-.03122	-.07591	-.27186	.06244	.04963	.04699	1.10040	1.12632
26	292.50000	6.67105	.48734	-1.17655	-.03600	.02393	-.28724	.07199	.09997	.04699	1.20223	1.14564
27	303.75000	6.67105	.70751	-1.05887	-.03893	.12307	-.26476	.07787	.13482	.04699	1.27274	1.15753
28	315.00000	6.67105	.90049	-.90049	-.03993	.20735	-.20735	.07985	.14730	.04699	1.29799	1.16154
29	326.25000	6.67105	1.05887	-.70751	-.03893	.26476	-.12307	.07787	.13482	.04699	1.27274	1.15753
30	337.50000	6.67105	1.17655	-.48734	-.03600	.28724	-.02393	.07199	.09997	.04699	1.20223	1.14564
31	348.75000	6.67105	1.24902	-.24845	-.03122	.27186	.07591	.06244	.04963	.04699	1.10040	1.12632
32	360.00000	6.67105	1.27349	.00000	-.02480	.22127	.16226	.04960	-.00729	.04699	.98525	1.10034

BODY RING= 5

BODY NOSE SEPARATION AT XB/RB = 5.52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .07510
VORTEX Y/RLOC (UNROLLED COORDS) = .63291
VORTEX Z/RLOC (UNROLLED COORDS) = 1.17494

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= .07510
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.38327
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.27835
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.07510
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.27835
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .38327

1	11.25000	8.72368	1.27502	.25362	.01846	.09244	.24186	-.03692	-.13846	0.00000	.71989	.92531
2	22.50000	8.72368	1.20104	.49749	.02098	-.00453	.25906	-.04195	-.17259	0.00000	.65086	.91513
3	33.75000	8.72368	1.08091	.72224	.02371	-.09954	.23610	-.04742	-.19340	0.00000	.60875	.90407
4	45.00000	8.72368	.91924	.91924	.02655	-.17601	.17601	-.05310	-.19873	0.00000	.59797	.89257
5	56.25000	8.72368	.72224	1.08091	.02939	-.21820	.08758	-.05879	-.18674	0.00000	.62223	.88108
6	67.50000	8.72368	.49749	1.20104	.03213	-.21115	-.01531	-.06425	-.15486	0.00000	.68673	.87002
7	78.75000	8.72368	.25362	1.27502	.03464	-.13639	-.11342	-.06929	-.09967	0.00000	.79837	.85983
8	90.00000	8.72368	-.00000	1.30000	.03685	.03919	-.17544	-.07370	-.02991	0.00000	.93950	.85090
9	101.25000	8.72368	-.25362	1.27502	.03866	.31798	-.14709	-.07733	-.03667	0.00000	.92583	.84357
10	112.50000	8.72368	-.49749	1.20104	.04001	.37297	-.09365	-.08002	-.06200	0.00000	.87458	.83812
11	123.75000	8.72368	-.72224	1.08091	.04084	.23609	-.13492	-.08168	-.02545	0.00000	.94852	.83477
12	135.00000	8.72368	-.91924	.91924	.04112	.17544	-.17544	-.08224	-.02079	0.00000	.95795	.83364
13	146.25000	8.72368	-1.08091	.72224	.04084	.13492	-.23609	-.08168	-.02545	0.00000	.94852	.83477
14	157.50000	8.72368	-1.20104	.49749	.04001	.09365	-.37297	-.08002	-.06200	0.00000	.87458	.83812
15	168.75000	8.72368	-1.27502	.25362	.03866	.14709	-.31798	-.07733	-.03667	0.00000	.92583	.84357
16	180.00000	8.72368	-1.30000	-.00000	.03685	.17544	-.03919	-.07370	-.02991	0.00000	.93950	.85090
17	191.25000	8.72368	-1.27502	-.25362	.03464	.11342	.13639	-.06929	-.09967	0.00000	.79837	.85983

Figure 6.- Continued.

18	202.50000	8.72368	-1.20104	-.49749	.03213	.01531	.21115	-.06425	-.15486	0.00000	.68675	.87002
19	213.75000	8.72368	-1.08091	-.72224	.02939	-.06758	.21820	-.05879	-.18674	0.00000	.62223	.88108
20	225.00000	8.72368	-.91924	-.91924	.02655	-.17601	.17601	-.05310	-.19873	0.00000	.59797	.89257
21	236.25000	8.72368	-.72224	-1.08091	.02371	-.23610	.09954	-.04742	-.19340	0.00000	.60875	.90407
22	247.50000	8.72368	-.49749	-1.20104	.02098	-.25906	.00453	-.04195	-.17259	0.00000	.65086	.91513
23	258.75000	8.72368	-.25362	-1.27502	.01846	-.24186	-.09244	-.03692	-.13846	0.00000	.71989	.92531
24	270.00000	8.72368	.00000	-1.30000	.01625	-.18759	-.17544	-.03250	-.09467	0.00000	.80849	.93425
25	281.25000	8.72368	.25362	-1.27502	.01444	-.10489	-.23121	-.02888	-.04710	0.00000	.90472	.94157
26	292.50000	8.72368	.49749	-1.20104	.01309	-.00668	-.25088	-.02619	-.00372	0.00000	.99247	.94702
27	303.75000	8.72368	.72224	-1.08091	.01227	.09183	-.23132	-.02453	.02686	0.00000	1.05435	.95037
28	315.00000	8.72368	.91924	-.91924	.01199	.17544	-.17544	-.02397	.03792	0.00000	1.07671	.95151
29	326.25000	8.72368	1.08091	-.72224	.01227	.23132	-.09183	-.02453	.02686	0.00000	1.05435	.95037
30	337.50000	8.72368	1.20104	-.49749	.01309	.25088	.00668	-.02619	-.00372	0.00000	.99247	.94702
31	348.75000	8.72366	1.27502	-.25362	.01444	.23121	.10489	-.02888	-.04710	0.00000	.90472	.94157
32	360.00000	8.72368	1.30000	-.00000	.01625	.17544	.18759	-.03250	-.09467	0.00000	.80849	.93425

BODY RING= 6

BODY NOSE SEPARATION AT XB/RB = 5.52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .07701
VORTEX Y/RLOC (UNROLLED COORDS) = .63679
VORTEX Z/RLOC (UNROLLED COORDS) = 1.22147

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= .07701
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.41343
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.31399
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.07701
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.31399
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .41343

1	11.25000	10.77632	1.27502	.25362	.01723	.09167	.24573	-.03446	-.13919	0.00000	.71841	.93030
2	22.50000	10.77632	1.20104	.49749	.01669	-.00614	.26294	-.03338	-.16925	0.00000	.65760	.93247
3	33.75000	10.77632	1.08091	.72224	.01611	-.10186	.23957	-.03222	-.18568	0.00000	.62437	.93482
4	45.00000	10.77632	.91924	.91924	.01550	-.17871	.17871	-.03101	-.18601	0.00000	.62371	.93727
5	56.25000	10.77632	.72224	1.08091	.01490	-.22080	.08932	-.02980	-.16797	0.00000	.66019	.93972
6	67.50000	10.77632	.49749	1.20104	.01432	-.21334	-.01441	-.02863	-.12865	0.00000	.73975	.94207
7	78.75000	10.77632	.25362	1.27502	.01378	-.13943	-.11281	-.02756	-.06501	0.00000	.86848	.94424
8	90.00000	10.77632	-.00000	1.30000	.01331	.02598	-.17544	-.02662	.01263	0.00000	1.02555	.94615
9	101.25000	10.77632	-.25362	1.27502	.01292	.27244	-.15615	-.02585	.02547	0.00000	1.05153	.94771
10	112.50000	10.77632	-.49749	1.20104	.01264	.34955	-.10333	-.02528	-.00024	0.00000	.99952	.94887
11	123.75000	10.77632	-.72224	1.08091	.01246	.24047	-.13199	-.02492	.03044	0.00000	1.06158	.94958
12	135.00000	10.77632	-.91924	.91924	.01240	.17544	-.17544	-.02480	.03706	0.00000	1.07497	.94982
13	146.25000	10.77632	-1.08091	.72224	.01246	.13199	-.24047	-.02492	.03044	0.00000	1.06158	.94958
14	157.50000	10.77632	-1.20104	.49749	.01264	.10333	-.34955	-.02528	-.00024	0.00000	.99952	.94887
15	168.75000	10.77632	-1.27502	.25362	.01292	.15615	-.27244	-.02585	.02547	0.00000	1.05153	.94771
16	180.00000	10.77632	-1.30000	-.00000	.01331	.17544	-.02598	-.02662	.01263	0.00000	1.02555	.94615
17	191.25000	10.77632	-1.27502	-.25362	.01378	.11281	.13943	-.02756	-.06501	0.00000	.86848	.94424
18	202.50000	10.77632	-1.20104	-.49749	.01432	.01441	.21334	-.02863	-.12865	0.00000	.73975	.94207
19	213.75000	10.77632	-1.08091	-.72224	.01490	-.08932	.22080	-.02980	-.16797	0.00000	.66019	.93972
20	225.00000	10.77632	-.91924	-.91924	.01550	-.17871	.17871	-.03101	-.18601	0.00000	.62371	.93727
21	236.25000	10.77632	-.72224	-1.08091	.01611	-.23957	.10186	-.03222	-.18568	0.00000	.62437	.93482
22	247.50000	10.77632	-.49749	-1.20104	.01669	-.26294	.00614	-.03338	-.16925	0.00000	.65760	.93247
23	258.75000	10.77632	-.25362	-1.27502	.01723	-.24573	-.09167	-.03446	-.13919	0.00000	.71841	.93030
24	270.00000	10.77632	.00000	-1.30000	.01770	-.19104	-.17544	-.03540	-.09925	0.00000	.79922	.92839
25	281.25000	10.77632	.25362	-1.27502	.01808	-.10759	-.23174	-.03617	-.05520	0.00000	.88853	.92683
26	292.50000	10.77632	.49749	-1.20104	.01837	-.00846	-.25162	-.03674	-.01473	0.00000	.97021	.92567

Figure 6.- Continued.

27	303.75000	10.77632	.72224	-1.08091	.01855	.09101	-.23186	-.03709	.01392	0.00000	1.02817	.92496
28	315.00000	10.77632	.91924	-.91924	.01861	.17544	-.17544	-.03721	.02430	0.00000	1.04915	.92472
29	326.25000	10.77632	1.08091	-.72224	.01855	.23186	-.09101	-.03709	.01392	0.00000	1.02817	.92496
30	337.50000	10.77632	1.20104	-.49749	.01837	.25162	.00846	-.03674	-.01473	0.00000	.97021	.92567
31	348.75000	10.77632	1.27502	-.25362	.01808	.23174	.10759	-.03617	-.05520	0.00000	.88833	.92683
32	360.00000	10.77632	1.30000	.00000	.01770	.17544	.19104	-.03540	-.09925	0.00000	.79922	.92839

BODY RING= 7

BODY NOSE SEPARATION AT XB/RB = 5.52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .07891
VORTEX Y/RLOC (UNROLLED COORDS) = .64087
VORTEX Z/RLOC (UNROLLED COORDS) = 1.26809

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= .07691
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.44345
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.34977
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.07891
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.34977
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .44345

1	11.25000	12.82895	1.27502	.25362	.01336	.09328	.23765	-.02672	-.12754	0.00000	.74199	.94594
2	22.50000	12.82895	1.20104	.49749	.01226	-.00257	.25433	-.02452	-.15614	0.00000	.68412	.95039
3	33.75000	12.82895	1.08091	.72224	.01107	-.09622	.23113	-.02214	-.17124	0.00000	.65359	.95522
4	45.00000	12.82895	.91924	.91924	.00983	-.17112	.17112	-.01965	-.17022	0.00000	.65564	.96024
5	56.25000	12.82895	.72224	1.08091	.00858	-.21166	.08321	-.01717	-.15079	0.00000	.69495	.96527
6	67.50000	12.82895	.49749	1.20104	.00739	-.20346	-.01850	-.01478	-.11026	0.00000	.77695	.97010
7	78.75000	12.82895	.25362	1.27502	.00629	-.13127	-.11444	-.01258	-.04674	0.00000	.90544	.97455
8	90.00000	12.82895	-.00000	1.30000	.00533	.02363	-.17544	-.01065	.02799	0.00000	1.05663	.97845
9	101.25000	12.82895	-.25362	1.27502	.00454	.24321	-.16196	-.00907	.04810	0.00000	1.09731	.98165
10	112.50000	12.82895	-.49749	1.20104	.00395	.32994	-.11145	-.00790	.02477	0.00000	1.05012	.98403
11	123.75000	12.82895	-.72224	1.08091	.00359	.24358	-.12992	-.00717	.04813	0.00000	1.09736	.98549
12	135.00000	12.62895	-.91924	.91924	.00346	.17544	-.17544	-.00693	.05568	0.00000	1.11264	.98599
13	146.25000	12.82895	-1.08091	.72224	.00359	.12992	-.24358	-.00717	.04813	0.00000	1.09736	.98549
14	157.50000	12.82895	-1.20104	.49749	.00395	.11145	-.32994	-.00790	.02477	0.00000	1.05012	.98403
15	168.75000	12.82895	-1.27502	.25362	.00454	.16196	-.24321	-.00907	.04810	0.00000	1.09731	.98165
16	180.00000	12.82895	-1.30000	-.00000	.00533	.17544	-.02363	-.01065	.02799	0.00000	1.05663	.97845
17	191.25000	12.62895	-1.27502	-.25362	.00629	.11444	.13127	-.01258	-.04674	0.00000	.90544	.97455
18	202.50000	12.82895	-1.20104	-.49749	.00739	.01850	.20346	-.01478	-.11026	0.00000	.77695	.97010
19	213.75000	12.82895	-1.08091	-.72224	.00858	-.08321	.21166	-.01717	-.15079	0.00000	.69495	.96527
20	225.00000	12.82895	-.91924	-.91924	.00983	-.17112	.17112	-.01965	-.17022	0.00000	.65564	.96024
21	236.25000	12.82895	-.72224	-1.08091	.01107	-.23113	.09622	-.02214	-.17124	0.00000	.65359	.95522
22	247.50000	12.82895	-.49749	-1.20104	.01226	-.25433	.00257	-.02452	-.15614	0.00000	.68412	.95039
23	258.75000	12.62895	-.25362	-1.27502	.01336	-.23765	-.09328	-.02672	-.12754	0.00000	.74199	.94594
24	270.00000	12.82895	.00000	-1.30000	.01433	-.18411	-.17544	-.02865	-.08923	0.00000	.81948	.94204
25	281.25000	12.82895	.25362	-1.27502	.01512	-.10230	-.23069	-.03023	-.04694	0.00000	.90503	.93884
26	292.50000	12.82895	.49749	-1.20104	.01570	-.00504	-.25020	-.03141	-.00813	0.00000	.98356	.93646
27	303.75000	12.82895	.72224	-1.08091	.01607	.09257	-.23082	-.03213	.01932	0.00000	1.03909	.93499
28	315.00000	12.82695	.91924	-.91924	.01619	.17544	-.17544	-.03238	.02925	0.00000	1.05918	.93450
29	326.25000	12.82895	1.08091	-.72224	.01607	.23082	-.09257	-.03213	.01932	0.00000	1.03909	.93499
30	337.50000	12.82895	1.20104	-.49749	.01570	.25020	.00504	-.03141	-.00813	0.00000	.98356	.93646
31	348.75000	12.82895	1.27502	-.25362	.01512	.23069	.10230	-.03023	-.04694	0.00000	.90503	.93884
32	360.00000	12.82895	1.30000	.00000	.01433	.17544	.18411	-.02865	-.08923	0.00000	.81948	.94204

Figure 6.- Continued.

BODY RINGS 8

BODY NOSE SEPARATION AT XB/RB = 5.52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .08082
VORTEX Y/RLOC (UNROLLED COORDS) = .64591
VORTEX Z/RLOC (UNROLLED COORDS) = 1.31453

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .08082
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.47279
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.38624
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.08082
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.38624
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .47279

1	11.25000	14.88158	1.27502	.25362	.00928	.09490	.22946	-.01855	-.11532	0.00000	.76670	.96247
2	22.50000	14.88158	1.20104	.49749	.00846	.00103	.24562	-.01691	-.14371	0.00000	.70927	.96579
3	33.75000	14.88158	1.08091	.72224	.00757	-.09054	.22262	-.01513	-.15873	0.00000	.67888	.96939
4	45.00000	14.88158	.91924	.91924	.00664	-.16351	.16351	-.01328	-.15776	0.00000	.68084	.97314
5	56.25000	14.88158	.72224	1.08091	.00571	-.20255	.07712	-.01143	-.13858	0.00000	.71965	.97689
6	67.50000	14.88158	.49749	1.20104	.00482	-.19377	-.02251	-.00964	-.09890	0.00000	.79993	.98049
7	78.75000	14.88158	.25362	1.27502	.00400	-.12339	-.11600	-.00800	-.03793	0.00000	.92326	.98381
8	90.00000	14.88158	-.00000	1.30000	.00328	.02217	-.17544	-.00656	.03169	0.00000	1.06410	.98672
9	101.25000	14.88158	-.25362	1.27502	.00269	.22012	-.16656	-.00538	.05492	0.00000	1.11111	.98911
10	112.50000	14.88158	-.49749	1.20104	.00225	.31040	-.11955	-.00451	.03517	0.00000	1.07114	.99089
11	123.75000	14.88158	-.72224	1.08091	.00198	.24356	-.12993	-.00397	.05147	0.00000	1.10412	.99198
12	135.00000	14.88158	-.91924	.91924	.00189	.17544	-.17544	-.00378	.05899	0.00000	1.11933	.99235
13	146.25000	14.88158	-1.08091	.72224	.00198	.12993	-.24356	-.00397	.05147	0.00000	1.10412	.99196
14	157.50000	14.88158	-1.20104	.49749	.00225	.11955	-.31040	-.00451	.03517	0.00000	1.07114	.99089
15	168.75000	14.88158	-1.27502	.25362	.00269	.16656	-.22012	-.00538	.05492	0.00000	1.11111	.98911
16	180.00000	14.88158	-1.30000	-.00000	.00328	.17544	-.02217	-.00656	.03169	0.00000	1.06410	.98672
17	191.25000	14.88158	-1.27502	-.25362	.00400	.11600	.12339	-.00800	-.03793	0.00000	.92326	.98381
18	202.50000	14.88158	-1.20104	-.49749	.00482	.02251	.19377	-.00964	-.09890	0.00000	.79993	.98049
19	213.75000	14.88158	-1.08091	-.72224	.00571	-.07712	.20255	-.01143	-.13858	0.00000	.71965	.97689
20	225.00000	14.88158	-.91924	-.91924	.00664	-.16351	.16351	-.01328	-.15776	0.00000	.68084	.97314
21	236.25000	14.88158	-.72224	-1.08091	.00757	-.22262	.09054	-.01513	-.15873	0.00000	.67888	.96939
22	247.50000	14.88158	-.49749	-1.20104	.00846	-.24562	-.00103	-.01691	-.14371	0.00000	.70927	.96579
23	258.75000	14.88158	-.25362	-1.27502	.00928	-.22946	-.09490	-.01855	-.11532	0.00000	.76670	.96247
24	270.00000	14.88158	.00000	-1.30000	.01000	-.17709	-.17544	-.01999	-.07743	0.00000	.84337	.95956
25	281.25000	14.88158	.25362	-1.27502	.01099	-.09693	-.22962	-.02117	-.03571	0.00000	.92775	.95717
26	292.50000	14.88158	.49749	-1.20104	.01102	-.00157	-.24877	-.02205	.00247	0.00000	1.00500	.95539
27	303.75000	14.88158	.72224	-1.08091	.01130	.09416	-.22976	-.02259	.02942	0.00000	1.05952	.95430
28	315.00000	14.88158	.91924	-.91924	.01139	.17544	-.17544	-.02277	.03916	0.00000	1.07922	.95393
29	326.25000	14.88158	1.08091	-.72224	.01130	.22976	-.09416	-.02259	.02942	0.00000	1.05952	.95430
30	337.50000	14.88158	1.20104	-.49749	.01102	.24877	.00157	-.02205	.00247	0.00000	1.00500	.95539
31	348.75000	14.88158	1.27502	-.25362	.01059	.22962	.09693	-.02117	-.03571	0.00000	.92775	.95717
32	360.00000	14.88158	1.30000	.00000	.01000	.17544	.17709	-.01999	-.07743	0.00000	.84337	.95956

BODY RINGS 9

BODY NOSE SEPARATION AT XB/RB = 5.52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .08272
VORTEX Y/RLOC (UNROLLED COORDS) = .65095
VORTEX Z/RLOC (UNROLLED COORDS) = 1.36106

Figure 6.- Continued.

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= .08272
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.50213
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.42271
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.08272
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.42271
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .50213

1	11.25000	16.93421	1.27502	.25362	.00617	.09596	.22413	-.01234	-.10656	0.00000	.78443	.97504
2	22.50000	16.93421	1.20104	.49749	.00572	.00339	.23992	-.01144	-.13511	0.00000	.72668	.97687
3	33.75000	16.93421	1.08091	.72224	.00523	-.08678	.21701	-.01046	-.15036	0.00000	.69582	.97884
4	45.00000	16.93421	.91924	.91924	.00472	-.15845	.15845	-.00944	-.14971	0.00000	.69714	.98090
5	56.25000	16.93421	.72224	1.08091	.00421	-.19647	.07306	-.00842	-.13103	0.00000	.73493	.98296
6	67.50000	16.93421	.49749	1.20104	.00372	-.18740	-.02515	-.00745	-.09241	0.00000	.81306	.98493
7	78.75000	16.93421	.25362	1.27502	.00327	-.11886	-.11690	-.00655	-.03396	0.00000	.93130	.98676
8	90.00000	16.93421	-.00000	1.30000	.00288	.01863	-.17544	-.00576	.03137	0.00000	1.06346	.98835
9	101.25000	16.93421	-.25362	1.27502	.00255	.19951	-.17066	-.00511	.05687	0.00000	1.11504	.98966
10	112.50000	16.93421	-.49749	1.20104	.00231	.29103	-.12757	-.00463	.04108	0.00000	1.08311	.99064
11	123.75000	16.93421	-.72224	1.08091	.00217	.24097	-.13166	-.00433	.05163	0.00000	1.10445	.99124
12	135.00000	16.93421	-.91924	.91924	.00212	.17544	-.17544	-.00423	.05852	0.00000	1.11838	.99144
13	146.25000	16.93421	-1.08091	.72224	.00217	.13166	-.24097	-.00433	.05163	0.00000	1.10445	.99124
14	157.50000	16.93421	-1.20104	.49749	.00231	.12757	-.29103	-.00463	.04108	0.00000	1.08311	.99064
15	168.75000	16.93421	-1.27502	.25362	.00255	.17066	-.19951	-.00511	.05687	0.00000	1.11504	.98966
16	180.00000	16.93421	-1.30000	-.00000	.00288	.17544	-.01863	-.00576	.03137	0.00000	1.06346	.98835
17	191.25000	16.93421	-1.27502	-.25362	.00327	.11690	.11886	-.00655	-.03396	0.00000	.93130	.98676
18	202.50000	16.93421	-1.20104	-.49749	.00372	.02515	.18740	-.00745	-.09241	0.00000	.81306	.98493
19	213.75000	16.93421	-1.08091	-.72224	.00421	-.07306	.19647	-.00842	-.13103	0.00000	.73493	.98296
20	225.00000	16.93421	-.91924	-.91924	.00472	-.15845	.15845	-.00944	-.14971	0.00000	.69714	.98090
21	236.25000	16.93421	-.72224	-1.08091	.00523	-.21701	.08678	-.01046	-.15036	0.00000	.69582	.97884
22	247.50000	16.93421	-.49749	-1.20104	.00572	-.23992	-.00339	-.01144	-.13511	0.00000	.72668	.97687
23	258.75000	16.93421	-.25362	-1.27502	.00617	-.22413	-.09596	-.01234	-.10656	0.00000	.78443	.97504
24	270.00000	16.93421	.00000	-1.30000	.00656	-.17254	-.17544	-.01313	-.06861	0.00000	.86120	.97345
25	281.25000	16.93421	.25362	-1.27502	.00689	-.09346	-.22893	-.01377	-.02695	0.00000	.94547	.97214
26	292.50000	16.93421	.49749	-1.20104	.00713	.00066	-.24784	-.01426	.01110	0.00000	1.02245	.97116
27	303.75000	16.93421	.72224	-1.08091	.00728	.09518	-.22908	-.01455	.03792	0.00000	1.07670	.97056
28	315.00000	16.93421	.91924	-.91924	.00733	.17544	-.17544	-.01465	.04760	0.00000	1.09629	.97036
29	326.25000	16.93421	1.08091	-.72224	.00728	.22908	-.09518	-.01455	.03792	0.00000	1.07670	.97056
30	337.50000	16.93421	1.20104	-.49749	.00713	.24784	-.00066	-.01426	.01110	0.00000	1.02245	.97116
31	348.75000	16.93421	1.27502	-.25362	.00689	.22893	.09346	-.01377	-.02695	0.00000	.94547	.97214
32	360.00000	16.93421	1.30000	.00000	.00656	.17544	.17254	-.01313	-.06861	0.00000	.86120	.97345

BODY RING= 10

BODY NOSE SEPARATION AT XB/RB = 5.52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .08688
VORTEX Y/RLOC (UNROLLED COORDS) = .65576
VORTEX Z/RLOC (UNROLLED COORDS) = 1.40759

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= .08688
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.53163
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.45901
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.08688
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.45901
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .53163

1	11.25000	18.98684	1.27502	.25362	.00416	.09660	.22095	-.00832	-.10104	0.00000	.79560	.98318
2	22.50000	18.98684	1.20104	.49749	.00395	.00485	.23640	-.00791	-.12964	0.00000	.73774	.98401
3	33.75000	18.98684	1.08091	.72224	.00373	-.08436	.21339	-.00746	-.14494	0.00000	.70679	.98491
4	45.00000	18.98684	.91924	.91924	.00350	-.15498	.15498	-.00700	-.14430	0.00000	.70809	.98584

Figure 6.- Continued.

5	56.25000	18.98684	.72224	1.08091	.00327	-.19196	.07004	-.00653	-.12567	0.00000	.74577	.98678
6	67.50000	18.98684	.49749	1.20104	.00304	-.18211	-.02734	-.00609	-.08742	0.00000	.82315	.98768
7	78.75000	18.98684	.25362	1.27502	.00284	-.11411	-.11785	-.00568	-.03043	0.00000	.93844	.98851
8	90.00000	18.98684	-.00000	1.30000	.00266	.01843	-.17544	-.00532	.03175	0.00000	1.06423	.98924
9	101.25000	18.98684	-.25362	1.27502	.00251	.18801	-.17295	-.00503	.05746	0.00000	1.11625	.98983
10	112.50000	18.98684	-.49749	1.20104	.00240	.27961	-.13230	-.00481	.04404	0.00000	1.08910	.99028
11	123.75000	18.98684	-.72224	1.08091	.00234	.24039	-.13205	-.00467	.05139	0.00000	1.10397	.99055
12	135.00000	18.98684	-.91924	.91924	.00231	.17544	-.17544	-.00463	.05810	0.00000	1.11754	.99064
13	146.25000	18.98684	-1.08091	.72224	.00234	.13205	-.24039	-.00467	.05139	0.00000	1.10397	.99055
14	157.50000	18.98684	-1.20104	.49749	.00240	.13230	-.27961	-.00481	.04404	0.00000	1.08910	.99028
15	168.75000	18.98684	-1.27502	.25362	.00251	.17295	-.18801	-.00503	.05746	0.00000	1.11625	.98983
16	180.00000	18.98684	-1.30000	-.00000	.00266	.17544	-.01843	-.00532	.03175	0.00000	1.06423	.98924
17	191.25000	18.98684	-1.27502	-.25362	.00284	.11785	.11411	-.00568	-.03043	0.00000	.93844	.98851
18	202.50000	18.98684	-1.20104	-.49749	.00304	.02734	.18211	-.00609	-.08742	0.00000	.82315	.98768
19	213.75000	18.98684	-1.08091	-.72224	.00327	-.07004	.19196	-.00653	-.12567	0.00000	.74577	.98678
20	225.00000	18.98684	-.91924	-.91924	.00350	-.15498	.15498	-.00700	-.14430	0.00000	.70809	.98584
21	236.25000	18.98684	-.72224	-1.08091	.00373	-.21339	.08436	-.00746	-.14494	0.00000	.70679	.98491
22	247.50000	18.98684	-.49749	-1.20104	.00395	-.23640	-.00485	-.00791	-.12960	0.00000	.73774	.98401
23	258.75000	18.98684	-.25362	-1.27502	.00416	-.22095	-.09660	-.00832	-.10104	0.00000	.79560	.98318
24	270.00000	18.98684	.00000	-1.30000	.00434	-.16989	-.17544	-.00867	-.06304	0.00000	.87247	.98245
25	281.25000	18.98684	.25362	-1.27502	.00448	-.09147	-.22854	-.00897	-.02137	0.00000	.95677	.98185
26	292.50000	18.98684	.49749	-1.20104	.00459	.00193	-.24732	-.00919	.01666	0.00000	1.03371	.98141
27	303.75000	18.98684	.72224	-1.08091	.00466	.09575	-.22869	-.00932	.04345	0.00000	1.08790	.98114
28	315.00000	18.98684	.91924	-.91924	.00468	.17544	-.17544	-.00937	.05312	0.00000	1.10746	.98105
29	326.25000	18.98684	1.08091	-.72224	.00466	.22869	-.09575	-.00932	.04345	0.00000	1.08790	.98114
30	337.50000	18.98684	1.20104	-.49749	.00459	.24732	-.00193	-.00919	.01666	0.00000	1.03371	.98141
31	348.75000	18.98684	1.27502	-.25362	.00448	.22854	.09147	-.00897	-.02137	0.00000	.95677	.98185
32	360.00000	18.98684	1.30000	.00000	.00434	.17544	.16989	-.00867	-.06304	0.00000	.87247	.98245

TOTAL NUMBER OF PRESSURE POINTS,JCPT= 428

CONTROL POINT COORDINATES FOR 3 CHORDWISE BY 5 SPANWISE PANELS ON WING 1 OR H, 5 SPANWISE ON WING 2 OR L
AND 5 SPANWISE PANELS ON WING 3 OR U, 5 SPANWISE ON WING 4 OR D

J	X(J)	Y(J)	Z(J)	BU(J)	BV(J)	BW(J)	VVRTX	WVRTX
1	1.23112	1.53096	0.00000	.30415E-02	.12608E+00	.12789E+00	0.	0.
2	2.38667	1.53096	0.00000	.25619E-02	.12617E+00	.12768E+00	0.	0.
3	3.54222	1.53096	0.00000	.22035E-02	.12622E+00	.12755E+00	0.	0.
4	1.41565	1.99870	0.00000	.30173E-02	.73266E-01	.75357E-01	0.	0.
5	2.48119	1.99870	0.00000	.25678E-02	.73453E-01	.75200E-01	0.	0.
6	3.54672	1.99870	0.00000	.22281E-02	.73581E-01	.75098E-01	0.	0.
7	1.60017	2.46640	0.00000	.30518E-02	.47405E-01	.49768E-01	0.	0.
8	2.57570	2.46640	0.00000	.26235E-02	.47650E-01	.49633E-01	0.	0.
9	3.55122	2.46640	0.00000	.22924E-02	.47827E-01	.49541E-01	0.	0.
10	1.78466	2.93403	0.00000	.31062E-02	.32808E-01	.35417E-01	0.	0.
11	2.67019	2.93403	0.00000	.26945E-02	.33091E-01	.35293E-01	0.	0.
12	3.55572	2.93403	0.00000	.23729E-02	.33299E-01	.35206E-01	0.	0.
13	1.96912	3.40158	0.00000	.32017E-02	.23701E-01	.26577E-01	0.	0.
14	2.76467	3.40158	0.00000	.28029E-02	.24011E-01	.26461E-01	0.	0.
15	3.56022	3.40158	0.00000	.24715E-02	.24266E-01	.26377E-01	0.	0.
16	1.23112	-1.53096	0.00000	.23353E-02	.12635E+00	.12789E+00	0.	0.
17	2.38667	-1.53096	0.00000	.21254E-02	.12638E+00	.12768E+00	0.	0.
18	3.54222	-1.53096	0.00000	.19174E-02	.12640E+00	.12755E+00	0.	0.
19	1.41565	-1.99870	0.00000	.22883E-02	.73972E-01	.75357E-01	0.	0.
20	2.48119	-1.99870	0.00000	.21091E-02	.70042E-01	.75200E-01	0.	0.

Figure 6.- Continued.

21	3.54672	-1.9987	0.00000	.19229E-02	.74077E-01	.75098E-01	0.	0.
22	1.60017	-2.46640	0.00000	.21980E-02	.48455E-01	.49768E-01	0.	0.
23	2.57570	-2.46640	0.00000	.20524E-02	.48538E-01	.49633E-01	0.	0.
24	3.55122	-2.46640	0.00000	.18969E-02	.48586E-01	.49541E-01	0.	0.
25	1.78466	-2.93403	0.00000	.21408E-02	.34196E-01	.35417E-01	0.	0.
26	2.67019	-2.93403	0.00000	.20174E-02	.34274E-01	.35293E-01	0.	0.
27	3.55572	-2.93403	0.00000	.18823E-02	.34317E-01	.35206E-01	0.	0.
28	1.96912	-3.40158	0.00000	.20349E-02	.25363E-01	.26577E-01	0.	0.
29	2.76467	-3.40158	0.00000	.19547E-02	.25464E-01	.26461E-01	0.	0.
30	3.56022	-3.40158	0.00000	.18804E-02	.25558E-01	.26377E-01	0.	0.
31	1.23112	0.00000	1.53096	.23353E-02	-.12789E+00	-.12635E+00	0.	0.
32	2.38667	0.00000	1.53096	.21254E-02	-.12768E+00	-.12638E+00	0.	0.
33	3.54222	0.00000	1.53096	.19174E-02	-.12755E+00	-.12640E+00	0.	0.
34	1.41565	0.00000	1.99870	.22883E-02	-.75357E-01	-.73972E-01	0.	0.
35	2.48119	0.00000	1.99870	.21091E-02	-.75200E-01	-.74042E-01	0.	0.
36	3.54672	0.00000	1.99870	.19229E-02	-.75098E-01	-.74077E-01	0.	0.
37	1.60017	0.00000	2.46640	.21980E-02	-.49768E-01	-.48455E-01	0.	0.
38	2.57570	0.00000	2.46640	.20524E-02	-.49633E-01	-.48538E-01	0.	0.
39	3.55122	0.00000	2.46640	.18969E-02	-.49541E-01	-.48586E-01	0.	0.
40	1.78466	0.00000	2.93403	.21408E-02	-.35417E-01	-.34196E-01	0.	0.
41	2.67019	0.00000	2.93403	.20174E-02	-.35293E-01	-.34274E-01	0.	0.
42	3.55572	0.00000	2.93403	.18823E-02	-.35206E-01	-.34317E-01	0.	0.
43	1.96912	0.00000	3.40158	.20349E-02	-.26577E-01	-.25363E-01	0.	0.
44	2.76467	0.00000	3.40158	.19547E-02	-.26461E-01	-.25464E-01	0.	0.
45	3.56022	0.00000	3.40158	.18804E-02	-.26377E-01	-.25558E-01	0.	0.
46	1.23112	0.00000	-1.53096	.30415E-02	-.12789E+00	-.12608E+00	0.	0.
47	2.38667	0.00000	-1.53096	.25619E-02	-.12768E+00	-.12617E+00	0.	0.
48	3.54222	0.00000	-1.53096	.22035E-02	-.12755E+00	-.12622E+00	0.	0.
49	1.41565	0.00000	-1.99870	.30173E-02	-.75357E-01	-.73266E-01	0.	0.
50	2.48119	0.00000	-1.99870	.25678E-02	-.75200E-01	-.73453E-01	0.	0.
51	3.54672	0.00000	-1.99870	.22281E-02	-.75098E-01	-.73581E-01	0.	0.
52	1.60017	0.00000	-2.46640	.30518E-02	-.49768E-01	-.47405E-01	0.	0.
53	2.57570	0.00000	-2.46640	.26235E-02	-.49633E-01	-.47650E-01	0.	0.
54	3.55122	0.00000	-2.46640	.22924E-02	-.49541E-01	-.47827E-01	0.	0.
55	1.78466	0.00000	-2.93403	.31062E-02	-.35417E-01	-.32808E-01	0.	0.
56	2.67019	0.00000	-2.93403	.26945E-02	-.35293E-01	-.33091E-01	0.	0.
57	3.55572	0.00000	-2.93403	.23729E-02	-.35206E-01	-.33299E-01	0.	0.
58	1.96912	0.00000	-3.40158	.32017E-02	-.26577E-01	-.23701E-01	0.	0.
59	2.76467	0.00000	-3.40158	.28029E-02	-.26461E-01	-.24011E-01	0.	0.
60	3.56022	0.00000	-3.40158	.24715E-02	-.26377E-01	-.24266E-01	0.	0.

CONTROL POINT COORDINATES FOR HIP*9 (WING FRAME)

J	X(J)	Y(J)	Z(J)	THU(J)	THV(J)	THW(J)
61	1.14000	1.25052	.24874	-.13891E-02	-.18221E-01	.34655E-02
62	1.14000	1.06014	.70836	-.15717E-01	-.88792E-02	.20553E-01
63	1.14000	.70836	1.06014	-.15717E-01	.20553E-01	-.88792E-02
64	1.14000	.24874	1.25052	-.13891E-02	.34655E-02	-.18221E-01
65	1.14000	-.24874	1.25052	-.13891E-02	-.34655E-02	-.18221E-01
66	1.14000	-.70836	1.06014	-.15717E-01	-.20553E-01	-.88792E-02
67	1.14000	-1.06014	.70836	-.15717E-01	.88792E-02	.20553E-01
68	1.14000	-1.25052	.24874	-.13891E-02	.18221E-01	.34655E-02
69	1.14000	-1.25052	-.24874	-.13891E-02	.18221E-01	-.34655E-02
70	1.14000	-1.06014	-.70836	-.15717E-01	.88792E-02	-.20553E-01

Figure 6.- Continued.

71	1.14000	-.70836	-1.06014	-.15717E-01	-.20553E-01	.88792E-02
72	1.14000	-.24874	-1.25052	-.13891E-02	-.34655E-02	.18221E-01
73	1.14000	.24874	-1.25052	-.13891E-02	.34655E-02	.18221E-01
74	1.14000	.70836	-1.06014	-.15717E-01	.20553E-01	.88792E-02
75	1.14000	1.06014	-.70836	-.15717E-01	-.88792E-02	-.20553E-01
76	1.14000	1.25052	-.24874	-.13891E-02	-.18221E-01	-.34655E-02
77	2.34000	1.25052	.24874	-.10617E-01	-.85805E-02	-.48355E-02
78	2.34000	1.06014	.70836	-.22211E-01	-.16042E-01	.68216E-02
79	2.34000	.70836	1.06014	-.22211E-01	.68216E-02	-.16042E-01
80	2.34000	.24874	1.25052	-.10617E-01	-.48355E-02	-.85805E-02
81	2.34000	-.24874	1.25052	-.10617E-01	.48355E-02	-.85805E-02
82	2.34000	-.70836	1.06014	-.22211E-01	-.68216E-02	-.16042E-01
83	2.34000	-1.06014	.70836	-.22211E-01	.16042E-01	.68216E-02
84	2.34000	-1.25052	.24874	-.10617E-01	.85805E-02	-.48355E-02
85	2.34000	-1.25052	-.24874	-.10617E-01	.85805E-02	.48355E-02
86	2.34000	-1.06014	-.70836	-.22211E-01	.16042E-01	-.68216E-02
87	2.34000	-.70836	-1.06014	-.22211E-01	-.68216E-02	.16042E-01
88	2.34000	-.24874	-1.25052	-.10617E-01	.48355E-02	.85805E-02
89	2.34000	.24874	-1.25052	-.10617E-01	-.48355E-02	.85805E-02
90	2.34000	.70836	-1.06014	-.22211E-01	.68216E-02	.16042E-01
91	2.34000	1.06014	-.70836	-.22211E-01	-.16042E-01	-.68216E-02
92	2.34000	1.25052	-.24874	-.10617E-01	-.85805E-02	.48355E-02
93	3.54000	1.25052	.24874	.20324E-01	.26782E-01	-.54507E-01
94	3.54000	1.06014	.70836	-.22241E-01	.11295E-01	.68311E-02
95	3.54000	.70836	1.06014	-.22241E-01	.68311E-02	.11295E-01
96	3.54000	.24874	1.25052	.20324E-01	-.54507E-01	.26782E-01
97	3.54000	-.24874	1.25052	.20323E-01	.54507E-01	.26782E-01
98	3.54000	-.70836	1.06014	-.22241E-01	-.68311E-02	.11295E-01
99	3.54000	-1.06014	.70836	-.22241E-01	-.11295E-01	.68311E-02
100	3.54000	-1.25052	.24874	.20323E-01	-.26782E-01	-.54507E-01
101	3.54000	-1.25052	-.24874	.20323E-01	-.26782E-01	.54507E-01
102	3.54000	-1.06014	-.70836	-.22241E-01	-.11295E-01	-.68311E-02
103	3.54000	-.70836	-1.06014	-.22241E-01	-.68311E-02	-.11295E-01
104	3.54000	-.24874	-1.25052	.20323E-01	.54507E-01	-.26782E-01
105	3.54000	.24874	-1.25052	.20323E-01	-.54507E-01	-.26782E-01
106	3.54000	.70836	-1.06014	-.22241E-01	.68311E-02	-.11295E-01
107	3.54000	1.06014	-.70836	-.22241E-01	.11295E-01	-.68311E-02
108	3.54000	1.25052	-.24874	.20324E-01	.26782E-01	.54507E-01

LOADING INFORMATION

```
          MACH NUMBER =   .17000E+01
      ANGLE OF ATTACK =   10.000 DEGREES
      SIDE SLIP ANGLE =   10.000 DEGREES
            WING AREA =   13.88888
       REFERENCE AREA =    5.30929
     REFERENCE LENGTH =    2.69000
  EXPOSED WING SPAN H =    9.88000
   MOMENT CENTER:  XM =   19.50000
                   ZM =    0.00000
```

U/VINE TYPE LOADING PRESSURE

Figure 6.- Continued.

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
DEFL. ANGLE DEG. =		0.00000	0.00000	0.00000	0.00000	
CTHR =	.63832E-01	.15958E-01	.15958E-01	.15958E-01	.15958E-01	
CZ =	.15789E+01	.66031E+00	.66031E+00	0.	0.	.25832E+00
CY =	-.15789E+01	0.	0.	-.66031E+00	-.66031E+00	-.25832E+00
CM =	-.15783E+01	-.64660E+00	-.64660E+00	0.	0.	-.28514E+00
CLN =	.15783E+01	0.	0.	.64660E+00	.64660E+00	.28514E+00
CRL =	.57937E-14	-.57494E+00	.57494E+00	-.57494E+00	.57494E+00	.24098E-15

FOLLOWING ARE IN WIND-AXIS SYSTEM

CL =	.21803E+01	.45653E+00	.45653E+00	.45653E+00	.45653E+00	.35414E+00
CY-IND =	.76117E-12	.46691E+00	.46691E+00	-.46691E+00	-.46691E+00	.72387E-12
CDI =	.48649E+00	.99193E-01	.99193E-01	.99193E-01	.99193E-01	.89715E-01
CDI/CL**2 =	.10234E+00					
CM-IND =	-.22321E+01	-.45721E+00	-.45721E+00	-.45721E+00	-.45721E+00	-.40328E+00
CLN-IND =	-.67146E-12	-.30202E+00	-.58440E+00	.58440E+00	.30202E+00	-.61640E-12

NOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW IS SUPERSONIC

--------------------RIGHT WING--------------------

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
1	.65426	.18936	0.00000	0.00000	.00040	0.00000	0.00000	0.00000	-.88666	0.00000	.13334
2	.85415	.18692	0.00000	0.00000	.00266	0.00000	0.00000	0.00000	.01136	0.00000	.40340
3	1.05402	.17369	0.00000	0.00000	.00215	0.00000	0.00000	0.00000	.06021	0.00000	.67342
4	1.25386	.14776	0.00000	0.00000	.00205	0.00000	0.00000	0.00000	.12554	0.00000	.94341
5	1.45367	.10536	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.20592	0.00000	1.21335
6	1.55556	0.00000							.48293		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = .59839E-02
SUMFZ2 = .27045E-01

Figure 6.- Continued.

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	.00307	.00054	3.64000	1.35100
2	2	.66667	.03561	.00686	3.64000	2.10067
3	3	1.00000	.04649	.01511	3.64000	2.85033

*****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Y.C.G.
1	.88621	3.27795

-------------------- LEFT WING --------------------

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
7	-.65426	.18936	0.00000	0.00000	-.00040	0.00000	0.00000	0.00000	.88666	0.00000	.13334
8	-.85415	.18692	0.00000	0.00000	-.00266	0.00000	0.00000	0.00000	-.01136	0.00000	.40340
9	-1.05402	.17389	0.00000	0.00000	-.00215	0.00000	0.00000	0.00000	-.06091	0.00000	.67342
10	-1.25386	.14706	0.00000	0.00000	-.00205	0.00000	0.00000	0.00000	-.12554	0.00000	.94341
11	-1.45367	.10308	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.20592	0.00000	1.21335
12	-1.65554	0.00000							-.48295		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = -.59839E-02
SUMFZ2 = -.27045E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	-.00307	-.00054	-3.64000	1.35100
2	2	.66667	-.03561	-.00686	-3.64000	2.10067
3	3	1.00000	-.04649	-.01511	-3.64000	2.85033

Figure 6.- Continued.

```
*****T.E. FIN VORTEX INFO*****

IVRT GAMMA/VINF    Y.C.G.

  2    -.88621    -3.27795


********************UPPER WING********************
```

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
13	.65426	.18936	0.00000	0.00000	.00040	0.00000	0.00000	0.00000	-.88666	0.00000	.13334
14	.85415	.18692	0.00000	0.00000	.00266	0.00000	0.00000	0.00000	.01136	0.00000	.40340
15	1.05402	.17389	0.00000	0.00000	.00215	0.00000	0.00000	0.00000	.06091	0.00000	.67347
16	1.25386	.14706	0.00000	0.00000	.00205	0.00000	0.00000	0.00000	.12554	0.00000	.94341
17	1.45367	.10308	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.20592	0.00000	1.21335
18	1.55556	0.00000							.48293		

```
SUMFX  =  0.
SUMFZ1 =  0.
SUMFZ2 =   .59839E-02
SUMFT2 =   .27045E-01
```

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	4	.33333	.00307	.00054	3.64000	1.35100
2	5	.66667	.03561	.00686	3.64000	2.10067
3	6	1.00000	.04649	.01511	3.64000	2.85033

```
*****T.E. FIN VORTEX INFO*****

IVRT GAMMA/VINF    Z.C.G.

  3    .88621    3.27795
```

Figure 6.- Continued.

-------------------LOWER WING--------------------

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
19	-.65426	.18936	0.00000	0.00000	-.00040	0.00000	0.00000	0.00000	.88666	0.00000	.13330
20	-.85415	.18692	0.00000	0.00000	-.00266	0.00000	0.00000	0.00000	-.01136	0.00000	.40340
21	-1.05402	.17389	0.00000	0.00000	-.00215	0.00000	0.00000	0.00000	-.06091	0.00000	.67342
22	-1.25386	.14706	0.00000	0.00000	-.00205	0.00000	0.00000	0.00000	-.12550	0.00000	.94341
23	-1.45367	.10308	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.20592	0.00000	1.21335
24	-1.55556	0.00000							-.48293		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = -.59839E-02
SUMFT2 = -.27045E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	7	.33333	-.00307	-.00054	-3.64000	1.35100
2	8	.66667	-.03561	-.00686	-3.64000	2.10067
3	9	1.00000	-.04619	-.01511	-3.64000	2.85033

*****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Z,C.G.
4	-.88621	-3.27795

VELOCITIES AND BERNOULLI PRESSURES AT CONTROL POINTS IMMEDIATELY ABOVE AND BELOW HORIZONTAL WING SURFACE

J	X(J)	Y(J)	Z(J)	UTOTA	VTOTA	WTOTA	PRESSA	UTOTB	VTOTB	WTOTB	PRESSB
1	1.231118	1.530959	0.000000	.150107	-.009157	-.173650	-.232106	-.186636	.185261	-.173650	.507944
2	2.386670	1.530959	0.000000	.129322	.070070	-.173650	-.185694	-.119079	.165680	-.173650	.336862
3	3.542222	1.530959	0.000000	.113465	.168769	-.314650	-.167160	-.068697	.203827	-.032650	.189374
4	1.415654	1.998701	0.000000	.251532	-.137014	-.173650	-.378470	-.111513	.072591	-.173650	.303894
5	2.481188	1.998701	0.000000	.130365	.023599	-.173650	-.195638	-.130793	.124119	-.173650	.362347

Figure 6.- Continued.

6	3.546723	1.998701	0.000000	.145735	.120139	-.314650	-.218875	-.051527	.158102	-.032650	.151621
7	1.600170	2.466397	0.000000	.176868	-.039452	-.173650	-.275450	-.179328	.166197	-.173650	.489158
8	2.575697	2.466397	0.000000	.167531	-.001452	-.173650	-.254622	-.118118	.108495	-.173650	.328461
9	3.551224	2.466397	0.000000	.237271	.088465	-.314650	-.337191	.044297	.125603	-.032650	-.047964
10	1.784662	2.934030	0.000000	.180450	-.031710	-.173650	-.278223	-.158842	.164180	-.173650	.436543
11	2.670193	2.934030	0.000000	.198586	-.055542	-.173650	-.305871	-.086151	.054054	-.173650	.237995
12	3.555723	2.934030	0.000000	.117778	.029484	-.314650	-.189044	-.036092	.059096	-.032650	.102817
13	1.969121	3.401580	0.000000	.126247	.042307	-.173650	-.185537	-.173276	.215247	-.173650	.470855
14	2.760672	3.401580	0.000000	.091750	.018390	-.173650	-.134517	-.099502	.092063	-.173650	.279928
15	3.560222	3.401580	0.000000	.212912	-.063327	-.314650	-.353055	.096642	.040951	-.032650	-.174457
16	1.231118	-1.530959	0.000000	.152073	.265202	-.173650	-.218753	-.184670	.070784	-.173650	.485707
17	2.386670	-1.530959	0.000000	.122868	.176860	-.173650	-.167575	-.125533	.081251	-.173650	.340432
18	3.542222	-1.530959	0.000000	.228762	.162463	-.314650	-.324682	.046600	.127406	-.032650	-.052137
19	1.415654	-1.998701	0.000000	.254058	.288904	-.173650	-.348754	-.108987	.079299	-.173650	.299637
20	2.481188	-1.998701	0.000000	.146320	.146063	-.173650	-.205016	-.114838	.045543	-.173650	.303185
21	3.546723	-1.998701	0.000000	.238483	.125737	-.314650	-.336291	.041221	.087774	-.032650	-.046884
22	1.600170	-2.466397	0.000000	.176014	.135310	-.173650	-.248710	-.180182	-.070339	-.173650	.397380
23	2.575697	-2.466397	0.000000	.170160	.102179	-.173650	-.242750	-.115489	-.007767	-.173650	.281738
24	3.551224	-2.466397	0.000000	.242287	.015453	-.314650	-.349987	.049313	-.021685	-.032650	-.089321
25	1.784662	-2.934030	0.000000	.179484	.098715	-.173650	-.255977	-.159807	-.097175	-.173650	.328657
26	2.670193	-2.934030	0.000000	.201080	.127385	-.173650	-.282531	-.083658	.017789	-.173650	.219104
27	3.555723	-2.934030	0.000000	.132135	.058671	-.314650	-.205623	-.021734	.029059	-.032650	.063939
28	1.969121	-3.401580	0.000000	.125080	.006756	-.173650	-.191249	-.174443	-.166173	-.173650	.302127
29	2.760672	-3.401580	0.000000	.090902	.031085	-.173650	-.130050	-.100350	-.042528	-.173650	.228046
30	3.560222	-3.401580	0.000000	.215752	.118024	-.314650	-.311259	.099483	.095648	-.032650	-.148916

VELOCITIES AND BERNOULLI PRESSURES AT CONTROL POINTS IMMEDIATELY TO RIGHT AND LEFT OF VERTICAL WING SURFACE

J	X(J)	Y(J)	Z(J)	UTOTR	VTOTR	WTOTR	PRESSR	UTOTL	VTOTL	WTOTL	PRESSL
31	1.231118	0.000000	1.530959	-.184670	.173650	-.070784	.485707	.152073	.173650	-.265202	-.218753
32	2.386670	0.000000	1.530959	-.125533	.173650	-.081251	.340432	.122868	.173650	-.176860	-.167575
33	3.542222	0.000000	1.530959	.046600	.314650	-.127406	-.052137	.228762	.032650	-.162463	-.324682
34	1.415654	0.000000	1.998701	-.108987	.173650	-.079299	.299637	.254058	.173650	-.288904	-.348754
35	2.481188	0.000000	1.998701	-.114838	.173650	-.045543	.303185	.146320	.173650	-.146063	-.205016
36	3.546723	0.000000	1.998701	.041221	.314650	-.087774	-.046884	.238483	.032650	-.125737	-.336291
37	1.600170	0.000000	2.466397	-.180182	.173650	.070339	.397380	.176014	.173650	-.135310	-.248710
38	2.575697	0.000000	2.466397	-.115489	.173650	.007767	.281738	.170160	.173650	-.102179	-.242750
39	3.551224	0.000000	2.466397	.049313	.314650	.021685	-.089321	.242287	.032650	-.015453	-.349987
40	1.784662	0.000000	2.934030	-.159807	.173650	.097175	.328657	.179484	.173650	-.098715	-.255977
41	2.670193	0.000000	2.934030	-.083658	.173650	-.017789	.219104	.201080	.173650	-.127385	-.282531
42	3.555723	0.000000	2.934030	-.021734	.314650	-.029059	.063939	.132135	.032650	-.058671	-.205623
43	1.969121	0.000000	3.401580	-.174443	.173650	.166173	.302127	.125080	.173650	-.006756	-.191249
44	2.760672	0.000000	3.401580	-.100350	.173650	.042528	.228046	.090902	.173650	-.031085	-.130050
45	3.560222	0.000000	3.401580	.099483	.314650	-.095648	-.148916	.215752	.032650	-.118024	-.311259
46	1.231118	0.000000	-1.530959	-.186636	.173650	-.185261	.507944	.150107	.173650	.009157	-.232106
47	2.386670	0.000000	-1.530959	-.119079	.173650	-.165680	.336862	.129322	.173650	-.070070	-.185698
48	3.542222	0.000000	-1.530959	-.068697	.314650	-.203827	.189374	.113465	.032650	-.168769	-.167160
49	1.415654	0.000000	-1.998701	-.111513	.173650	-.072591	.303894	.251532	.173650	.137014	-.376070
50	2.481188	0.000000	-1.998701	-.130793	.173650	-.124119	.362347	.130365	.173650	-.023509	-.195638
51	3.546723	0.000000	-1.998701	-.051527	.314650	-.158102	.151621	.145735	.032650	-.120139	-.218875
52	1.600170	0.000000	-2.466397	-.179328	.173650	-.166197	.489158	.176868	.173650	.039452	-.275450
53	2.575697	0.000000	-2.466397	-.118118	.173650	-.108495	.328461	.167531	.173650	.001452	-.254622
54	3.551224	0.000000	-2.466397	.044297	.314650	-.125603	-.047964	.237271	.032650	-.088465	-.337191
55	1.784662	0.000000	-2.934030	-.158842	.173650	-.164180	.436543	.180450	.173650	.031710	-.278223
56	2.670193	0.000000	-2.934030	-.086151	.173650	-.054054	.237995	.198586	.173650	.055542	-.305871
57	3.555723	0.000000	-2.934030	-.036092	.314650	-.059096	.102817	.117778	.032650	-.029484	-.189044

Figure 6.- Continued.

58	1.969121	0.000000	-3.401580	-.173276	.173650	-.215237	.470855	.126247	.173650	-.042307	-.185537
59	2.764672	0.000000	-3.401580	-.099502	.173650	-.092003	.279928	.091750	.173650	-.018390	-.134517
60	3.560222	0.000000	-3.401580	.096642	.314650	.040951	-.170457	.212912	.032650	.063327	-.333055

PRESSURE LOADINGS AT CONTROL POINTS

J	X(J)	Y(J)	Z(J)	DELTP.LIN.	DELTP.HERN.
1	1.231118	1.530959	0.000000	.673486	.740049
2	2.386670	1.530959	0.000000	.496803	.522560
3	3.542222	1.530959	0.000000	.364325	.356534
4	1.415654	1.998701	0.000000	.726090	.682364
5	2.481188	1.998701	0.000000	.522316	.557985
6	3.546723	1.998701	0.000000	.394522	.370496
7	1.600170	2.466397	0.000000	.712392	.764608
8	2.575697	2.466397	0.000000	.571298	.543083
9	3.551224	2.466397	0.000000	.385949	.289228
10	1.784662	2.934030	0.000000	.678583	.714766
11	2.670193	2.934030	0.000000	.569475	.543868
12	3.555723	2.934030	0.000000	.307739	.291860
13	1.969121	3.401580	0.000000	.599046	.656392
14	2.764672	3.401580	0.000000	.382503	.414445
15	3.560222	3.401580	0.000000	.232539	.158598
16	1.231118	-1.530959	0.000000	.673486	.704460
17	2.386670	-1.530959	0.000000	.496803	.508007
18	3.542222	-1.530959	0.000000	.364325	.272545
19	1.415654	-1.998701	0.000000	.726090	.648391
20	2.481188	-1.998701	0.000000	.522316	.508200
21	3.546723	-1.998701	0.000000	.394522	.289407
22	1.600170	-2.466397	0.000000	.712392	.646089
23	2.575697	-2.466397	0.000000	.571298	.524487
24	3.551224	-2.466397	0.000000	.385949	.260665
25	1.784662	-2.934030	0.000000	.678583	.584635
26	2.670193	-2.934030	0.000000	.569475	.501635
27	3.555723	-2.934030	0.000000	.307739	.269561
28	1.969121	-3.401580	0.000000	.599046	.493376
29	2.764672	-3.401580	0.000000	.382503	.358096
30	3.560222	-3.401580	0.000000	.232539	.162342
31	1.231118	0.000000	1.530959	.673486	.704460
32	2.386670	0.000000	1.530959	.496803	.508007
33	3.542222	0.000000	1.530959	.364325	.272545
34	1.415654	0.000000	1.998701	.726090	.648391
35	2.481188	0.000000	1.998701	.522316	.508200
36	3.546723	0.000000	1.998701	.394522	.289407
37	1.600170	0.000000	2.466397	.712392	.646089
38	2.575697	0.000000	2.466397	.571298	.524487
39	3.551224	0.000000	2.466397	.385949	.260669
40	1.784662	0.000000	2.934030	.678583	.584635
41	2.670193	0.000000	2.934030	.569475	.501635
42	3.555723	0.000000	2.934030	.307739	.269561
43	1.969121	0.000000	3.401580	.599046	.493376
44	2.764672	0.000000	3.401580	.382503	.358096
45	3.560222	0.000000	3.401580	.232539	.162342
46	1.231118	0.000000	-1.530959	.673486	.740049
47	2.386670	0.000000	-1.530959	.496803	.522560
48	3.542222	0.000000	-1.530959	.364325	.356534
49	1.415654	0.000000	-1.998701	.726090	.682364

Figure 6.- Continued.

50	2.481188	0.000000	-1.998701	.522316	.557985
51	3.546725	0.000000	-1.998701	.394522	.370496
52	1.690170	0.000000	-2.466397	.712392	.764608
53	2.575697	0.000000	-2.466397	.571298	.583083
54	3.551224	0.000000	-2.466397	.385909	.289228
55	1.784662	0.000000	-2.934030	.678583	.714766
56	2.670193	0.000000	-2.934030	.569475	.543966
57	3.555725	0.000000	-2.934030	.307739	.291860
58	1.969121	0.000000	-3.401580	.599046	.656392
59	2.764672	0.000000	-3.401580	.382503	.414885
60	3.560222	0.000000	-3.401580	.232539	.158598

LOADING INFORMATION

MACH NUMBER = .17000E+01
ANGLE OF ATTACK = 10.000 DEGREES
SIDE SLIP ANGLE = 10.000 DEGREES
WING AREA = 13.58666
REFERENCE AREA = 5.30929
REFERENCE LENGTH = 2.69000
EXPOSED WING SPAN B = 4.68000
MOMENT CENTER: XM = 13.50000
ZM = 0.00000

BERNOULLI TYPE LOADING PRESSURE

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
DEFL. ANGLE DEG. =		0.00000	0.00000	0.00000	0.00000	
CTHR =	.61347E-01	.16075E-01	.14598E-01	.14598E-01	.16075E-01	
CZ =	.15087E+01	.66375E+00	.58666E+00	0.	0.	.25832E+00
CY =	-.15087E+01	0.	0.	-.58666E+00	-.66375E+00	-.25832E+00
CM =	-.14851E+01	-.63862E+00	-.56128E+00	0.	0.	-.28518E+00
CLN =	.14851E+01	0.	0.	.56128E+00	.63862E+00	.28518E+00
CLL =	.64190E-13	-.57593E+00	.50480E+00	-.50480E+00	.57593E+00	.24098E-15

FOLLOWING ARE IN WIND-AXIS SYSTEM

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
CL =	.20834E+01	.45892E+00	.40571E+00	.40571E+00	.45892E+00	.35414E+00
CY-IND =	.72269E-12	.46934E+00	.41483E+00	-.41483E+00	-.46934E+00	.72387E-12
CDT =	.46452E+00	.99677E-01	.87723E-01	.87723E-01	.99677E-01	.89715E-01
CDT/CL**2 =	.10702E+00					
CM-IND =	-.21002E+01	-.45157E+00	-.39688E+00	-.39688E+00	-.45157E+00	-.40328E+00
CLN-IND =	-.65725E-12	-.29631E+00	-.50870E+00	.50870E+00	.29631E+00	-.61640E-12

NOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW IS SUPERSONIC

Figure 6.- Continued.

********************RIGHT WING********************

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
1	.65426	.19979	0.00000	0.00000	.00325	0.00000	0.00000	0.00000	-.93550	0.00000	.13334
2	.85415	.18327	0.00000	0.00000	.00106	0.00000	0.00000	0.00000	.07730	0.00000	.40349
3	1.05402	.17048	0.00000	0.00000	.00208	0.00000	0.00000	0.00000	.05978	0.00000	.67342
4	1.25386	.14656	0.00000	0.00000	.00203	0.00000	0.00000	0.00000	.11192	0.00000	.94341
5	1.45367	.10438	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.19747	0.00000	1.21335
6	1.55556	0.00000							.48904		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = .69542E-02
SUMFT2 = .28353E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	.00337	.00060	3.64000	1.35100
2	2	.66667	.03885	.00749	3.64000	2.10067
3	3	1.00000	.04707	.01984	3.64000	2.85033

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Y.C.G.
1	.93503	3.18446

Figure 6.- Continued.

------------------- LEFT WING ---------------------

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	YLE
7	-.65426	.18324	0.00000	0.00000	-.00362	0.00000	0.00000	0.00000	.85800	0.00000	.13334
8	-.85415	.16451	0.00000	0.00000	-.00281	0.00000	0.00000	0.00000	-.08762	0.00000	.40340
9	-1.05402	.14906	0.00000	0.00000	-.00182	0.00000	0.00000	0.00000	-.07227	0.00000	.67342
10	-1.25386	.12816	0.00000	0.00000	-.00197	0.00000	0.00000	0.00000	-.09779	0.00000	.94341
11	-1.45367	.08608	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.19704	0.00000	1.21335
12	-1.55556	0.00000							-.40327		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = -.84305E-02
SUMFT2 = -.22939E-01

SIDE EDGE DISTRIBUTIONS

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	-.00253	-.00045	-3.64000	1.35100
2	2	.66667	-.03089	-.00593	-3.64000	2.10067
3	3	1.00000	-.03882	-.01281	-3.64000	2.85033

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Y.C.G.
2	-.85757	-3.11604

Figure 6.- Continued.

********************UPPER WING*********************

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
13	.65426	.18324	0.00000	0.00000	.00362	0.00000	0.00000	0.00000	-.85800	0.00000	.13334
14	.85415	.16451	0.00000	0.00000	.00281	0.00000	0.00000	0.00000	.08762	0.00000	.40340
15	1.05402	.14966	0.00000	0.00000	.00182	0.00000	0.00000	0.00000	.07227	0.00000	.67342
16	1.25386	.12816	0.00000	0.00000	.00197	0.00000	0.00000	0.00000	.09779	0.00000	.94341
17	1.45367	.08638	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.19704	0.00000	1.21335
18	1.55556	0.00000							.40327		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = .84305E-02
SUMFT2 = .22939E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	4	.33333	.00253	.00045	3.64000	1.35100
2	5	.66667	.03089	.00593	3.64000	2.10067
3	6	1.00000	.03882	.01281	3.64000	2.85033

****T.E. FIN VORTEX INFO******

IVRT	GAMMA/VINF	Z.C.G.
3	.85757	3.11604

Figure 6.- Continued.

*********************LOWER WING*********************

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	C1*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LF/VINF	XLE
19	-.65426	.19979	0.00000	0.00000	-.00325	0.00000	0.00000	0.00000	.93556	0.00000	.13550
20	-.85415	.18327	0.00000	0.00000	-.00106	0.00000	0.00000	0.00000	-.07730	0.00000	.40340
21	-1.05402	.17048	0.00000	0.00000	-.00208	0.00000	0.00000	0.00000	-.05978	0.00000	.67342
22	-1.25386	.14656	0.00000	0.00000	-.00203	0.00000	0.00000	0.00000	-.11192	0.00000	.94341
23	-1.45367	.10438	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.19747	0.00000	1.21335
24	-1.55556	0.00000							-.48904		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = -.69542E-02
SUMTZ = -.28355E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SP /VINF	ZBAR	XSE
1	7	.33333	-.00337	-.00060	-3.64000	1.35100
2	8	.66667	-.03885	-.00749	-3.64000	2.10067
3	9	1.00000	-.04707	-.01584	-3.64000	2.85033

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Z.C.G.
4	-.93505	-3.18446

****
AFT OF LEADING EDGE OF FIN ROOTCHORDS

Figure 6.- Continued.

PRESSURE COEFFICIENTS AT POINTS ON BODY MERIDIANS

J	THETA, DEG.	XH	YH	ZH	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF., BERN.	P/PINF., LIN.
						BODY RING= 1						
1	11.25000	20.94000	1.25052	.24874	.11130	.12273	.11776	-.22260	-.21167	0.00000	.57179	.54968
2	33.75000	20.94000	1.06014	.70836	.02622	-.09448	.23203	-.05244	-.19266	0.00000	.61026	.89390
3	56.25000	20.94000	.70836	1.06014	-.05100	-.19760	.07152	.10199	-.04014	0.00000	.91880	1.20633
4	78.75000	20.94000	.24874	1.25052	-.12330	-.10673	-.12489	.24661	.23477	0.00000	1.47494	1.49888
5	101.25000	20.94000	-.24874	1.25052	.11085	.02473	-.21377	-.22171	-.16584	0.00000	.66451	.55149
6	123.75000	20.94000	-.70836	1.06014	.02416	.11698	-.22613	-.04832	.00696	0.00000	1.01407	.90226
7	146.25000	20.94000	-1.06014	.70836	.02416	.22613	-.11698	-.04832	.00696	0.00000	1.01407	.90226
8	168.75000	20.94000	-1.25052	.24874	.11085	.21377	-.02473	-.22171	-.16584	0.00000	.66451	.55149
9	191.25000	20.94000	-1.25052	-.24874	-.12330	.12489	.10673	.24661	.23477	0.00000	1.47494	1.49888
10	213.75000	20.94000	-1.06014	-.70836	-.05100	-.07152	.19760	.10199	-.04014	0.00000	.91880	1.20633
11	236.25000	20.94000	-.70836	-1.06014	.02622	-.23203	.09448	-.05244	-.19266	0.00000	.61026	.89390
12	258.75000	20.94000	-.24874	-1.25052	.11130	-.11776	-.12273	-.22260	-.21167	0.00000	.57179	.54968
13	281.25000	20.94000	.24874	-1.25052	-.12286	.03577	-.21161	.24571	.31677	0.00000	1.64083	1.49707
14	303.75000	20.94000	.70836	-1.06014	-.04893	.15140	-.20317	.09787	.16871	0.00000	1.34131	1.19798
15	326.25000	20.94000	1.06014	-.70836	-.04893	.20317	-.15140	.09787	.16871	0.00000	1.34131	1.19798
16	348.75000	20.94000	1.25052	-.24874	-.12286	.21161	-.03577	.24571	.31677	0.00000	1.64083	1.49707
						BODY RING= 2						
1	11.25000	22.14000	1.25052	.24874	.10021	.12916	.08542	-.20841	-.18841	0.00000	.61884	.57838
2	33.75000	22.14000	1.06014	.70836	.01537	-.02324	.12539	-.03074	-.09119	0.00000	.81552	.93781
3	56.25000	22.14000	.70836	1.06014	-.07275	-.09832	.00518	.14551	.09614	0.00000	1.19449	1.29436
4	78.75000	22.14000	.24874	1.25052	-.11800	-.08813	-.12859	.23600	.23666	0.00000	1.47876	1.47742
5	101.25000	22.14000	-.24874	1.25052	.11874	.02657	-.21341	-.23748	-.17802	0.00000	.63987	.51958
6	123.75000	22.14000	-.70836	1.06014	.10747	.12241	-.22251	-.21494	-.14596	0.00000	.70473	.56517
7	146.25000	22.14000	-1.06014	.70836	.10747	.22251	-.12241	-.21494	-.14596	0.00000	.70473	.56517
8	168.75000	22.14000	-1.25052	.24874	.11874	.21341	-.02657	-.23748	-.17802	0.00000	.63987	.51958
9	191.25000	22.14000	-1.25052	-.24874	-.11800	.12859	.08813	.23600	.23666	0.00000	1.47876	1.47742
10	213.75000	22.14000	-1.06014	-.70836	-.07275	-.00518	.09832	.14551	.09614	0.00000	1.19449	1.29436
11	236.25000	22.14000	-.70836	-1.06014	.01537	-.12539	.02324	-.03074	-.09119	0.00000	.81552	.93781
12	258.75000	22.14000	-.24874	-1.25052	.10021	-.08542	-.12916	-.20841	-.18841	0.00000	.61884	.57838
13	281.25000	22.14000	.24874	-1.25052	-.13253	.02387	-.21397	.26506	.33497	0.00000	1.67765	1.53622
14	303.75000	22.14000	.70836	-1.06014	-.16485	.14948	-.20445	.32971	.44960	0.00000	1.90954	1.66699
15	326.25000	22.14000	1.06014	-.70836	-.16485	.20445	-.14948	.32971	.44960	0.00000	1.90954	1.66699
16	348.75000	22.14000	1.25052	-.24874	-.13253	.21397	-.02387	.26506	.33497	0.00000	1.67765	1.53622
						BODY RING= 3						
1	11.25000	23.34000	1.25052	.24874	.07229	.14316	.01498	-.14459	-.11128	0.00000	.77488	.70750
2	33.75000	23.34000	1.06014	.70836	.00171	.00802	.07860	-.00342	-.03324	0.00000	.93275	.99307
3	56.25000	23.34000	.70836	1.06014	-.01831	-.08238	-.00548	.03662	.00163	0.00000	1.00331	1.07408
4	78.75000	23.34000	.24874	1.25052	-.00643	-.13339	-.11960	.01285	-.02404	0.00000	.95137	1.02601
5	101.25000	23.34000	-.24874	1.25052	.17952	.06566	-.20564	-.35904	-.26020	0.00000	.47362	.27367
6	123.75000	23.34000	-.70836	1.06014	.15449	.12491	-.22084	-.30897	-.21983	0.00000	.55528	.37495
7	146.25000	23.34000	-1.06014	.70836	.15449	.22084	-.12491	-.30897	-.21983	0.00000	.55528	.37495
8	168.75000	23.34000	-1.25052	.24874	.17952	.20564	-.06566	-.35904	-.26020	0.00000	.47362	.27367
9	191.25000	23.34000	-1.25052	-.24874	-.00643	.11960	.13339	.01285	-.02404	0.00000	.95137	1.02601
10	213.75000	23.34000	-1.06014	-.70836	-.01831	.00548	.08238	.03662	.00163	0.00000	1.00331	1.07408

Figure 6.- Continued.

11	236.25000	23.34000	-.70836	-1.06014	.00171	-.07860	-.00802	-.00342	-.03524	0.00000	.93275	.99307
12	258.75000	23.34000	-.24874	-1.25052	.07229	-.01498	-.14316	-.10459	-.11128	0.00000	.77488	.70750
13	281.25000	23.34000	.24874	-1.25052	-.11365	-.05276	-.22921	.22730	.24834	0.00000	1.50240	1.45983
14	303.75000	23.34000	.70836	-1.06014	-.17108	.12113	-.22339	.34217	.45961	0.00000	1.92980	1.69220
15	326.25000	23.34000	1.06014	-.70836	-.17108	.22339	-.12113	.34217	.45961	0.00000	1.92980	1.69220
16	348.75000	23.34000	1.25052	-.24874	-.11365	.22921	.05276	.22730	.24834	0.00000	1.50240	1.45983

Figure 6.- Concluded.

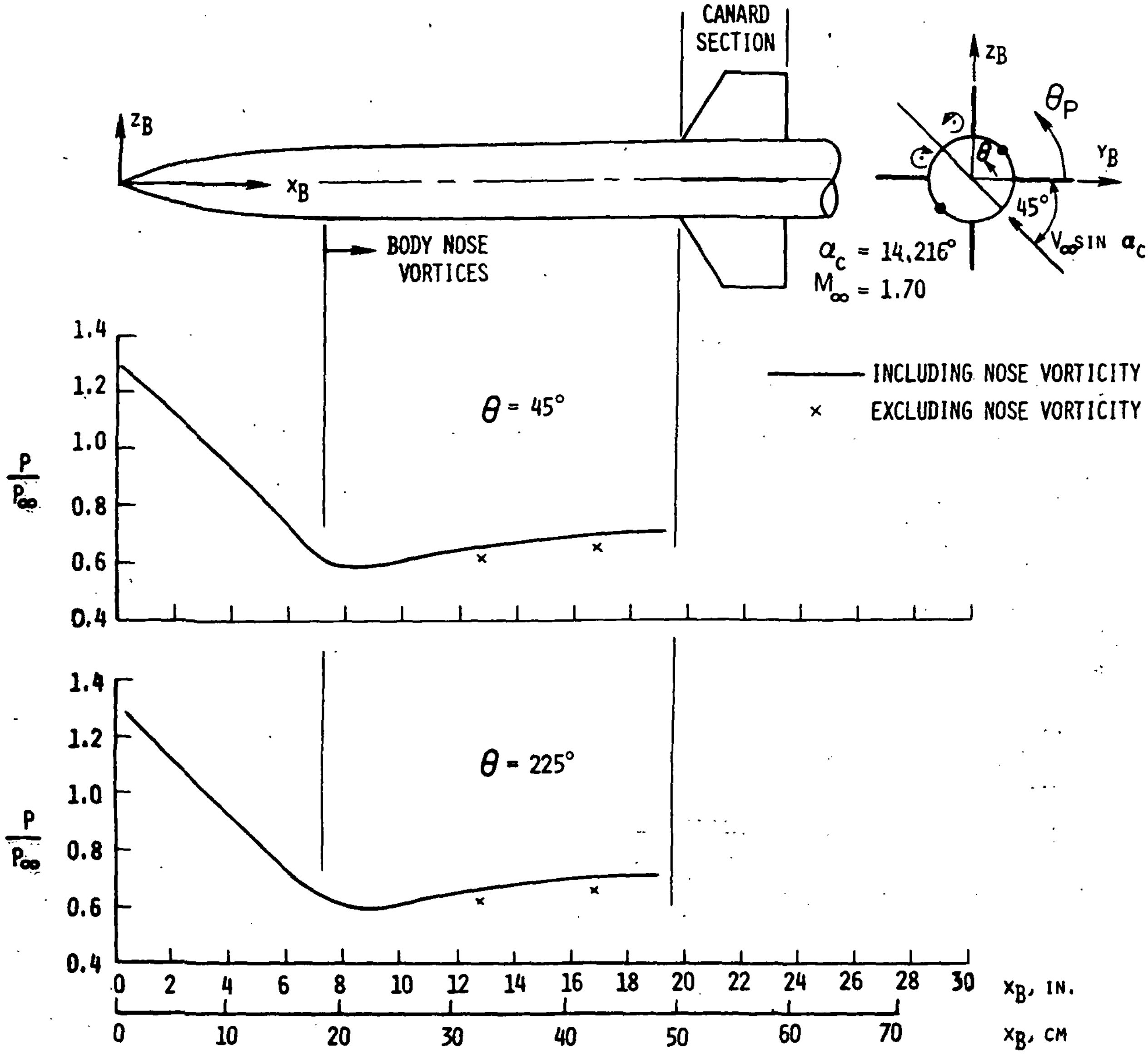


Figure 7(a).- Calculated pressure distributions along body meridians up to canard section; first sample case.

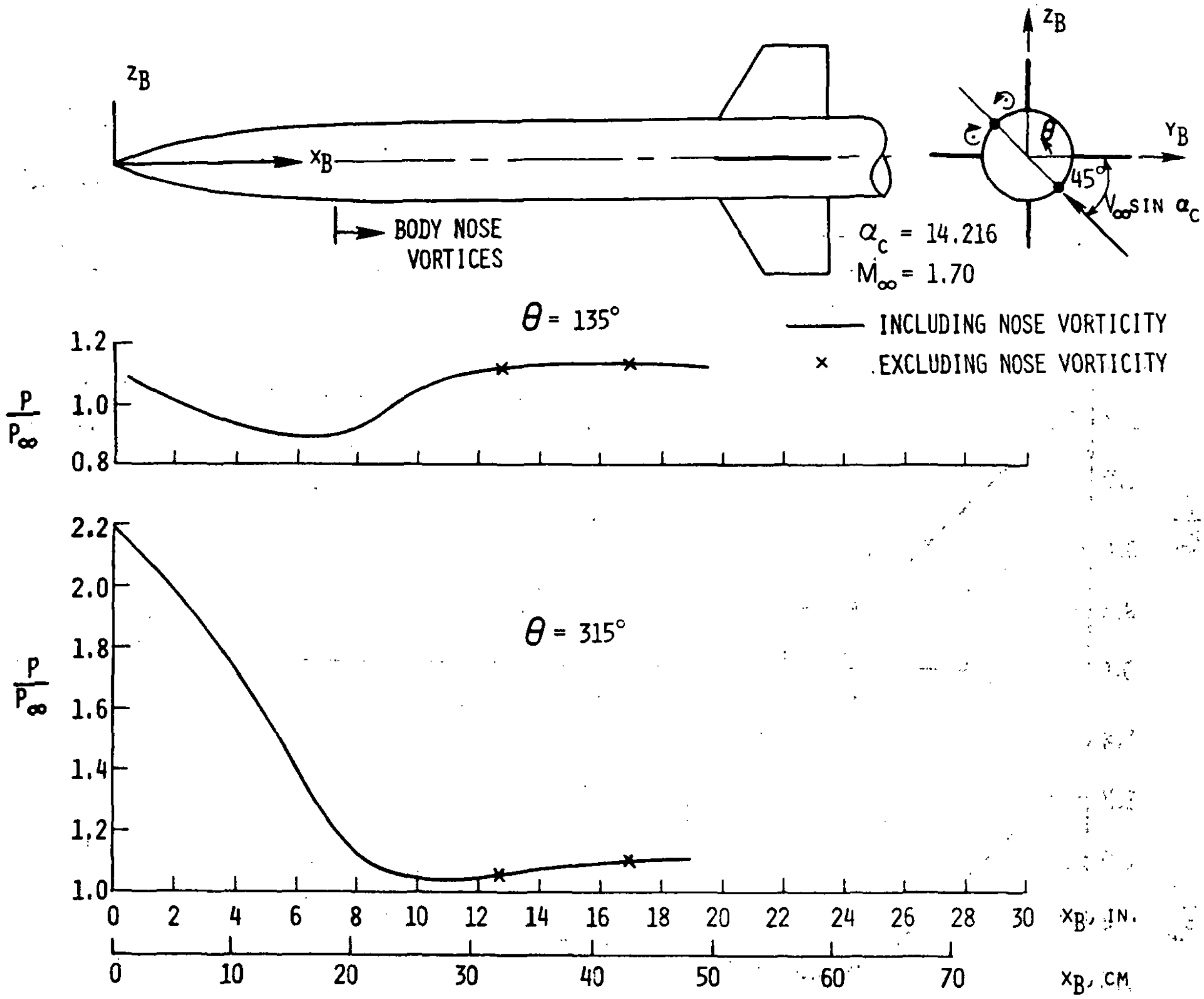


Figure 7(b).- Concluded.

```
NASA/LRC PROJECT 1126,CONFIGURATION B1W4,CHASE NOSE VORTICES PAST CANARD SECTION
          1          4          11          1          1          0          1
   23.4
  1.3
  19.8      1.3          21.151     3.64      23.4       3.64        23.400001   1.3
 14.216     45.0                                                    0.0001      0.35
   2    2    2    2    2    2    2    2    2    2    2
 -0.64337   1.8382   0.8024   -1.8382   0.64337   -0.8024
 19.8     20.163     20.514   20.878    21.242    21.606    21.957     22.321
  22.685   23.036     23.4
          0          0          0          0
          0
```

Figure 8.- Input for program VPATH2, first sample case, step 2.

```
NASA/LRC PROJECT 1126,CONFIGURATION 81-4,CHASE NOSE VORTICES PAST CANARD SECTION


          FIN GEOMETRY
      FIN SEMISPAN            =     3.64000
      FIN ROOTCHORD           =     3.60000
      FIN ROOT L.E. X-STATION=     19.60000
               L.E. Y-STATION=      1.30000
      FIN TIP L.E. X-STATION =     21.15100
              L.E. Y-STATION =      3.64000
      FIN TIP T.E. X-STATION =     23.40000
              T.E. Y-STATION =      3.64000
      FIN ROOT T.E. X-STATION=     23.40000
               T.E. Y-STATION=      1.30000


   INCLUDED ANGLE OF ATTACK(DEG) =    14.21600      ROLL ANGLE(DEG)   =    45.00000

     PANEL DEFL.(DEG) :

       DELTA1=  0.000   DELTA2=  0.000   DELTA3=  0.000   DELTA4=  0.000


****PERMISSIBLE RELATIVE ERROR,ES,USED IN INTEGRATION SCHEME =   .10000E-03


       VORTEX COORDINATES IN CROSS-FLOW PLANE


     INITIAL VORTEX POSITIONS AT    X = 19.800

   LOCAL BODY RADIUS =     1.30000     LOCAL SEMI SPAN S =     1.30000

       VORTEX              Y,VRTX             Z,VRTX        GAMMA/VINF

          1            -.64337E+00         .18382E+01      .80240E+00
          2            -.18382E+01         .64337E+00     -.80240E+00

   X-STATION NO.  2         X=20.163        INTEGRATION STEP SIZE =      .18150


   LOCAL BODY RADIUS =     1.30000     LOCAL SEMI SPAN S =     1.92873

       VORTEX              Y,VRTX             Z,VRTX        GAMMA/VINF
```

Figure 9.- Output of program VPATH2, first sample case, step 2.

1	-.68037E+00	.18568E+01	.80240E+00
2	-.18568E+01	.68037E+00	-.80240E+00

X-STATION NO. 3 X=20.514 INTEGRATION STEP SIZE = .18150

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 2.53668

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.70316E+00	.18633E+01	.80240E+00
2	-.18633E+01	.70316E+00	-.80240E+00

X-STATION NO. 4 X=20.878 INTEGRATION STEP SIZE = .18150

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 3.16715

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.70923E+00	.18674E+01	.80240E+00
2	-.18674E+01	.70923E+00	-.80240E+00

X-STATION NO. 5 X=21.242 INTEGRATION STEP SIZE = .18150

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.70610E+00	.18736E+01	.80240E+00
2	-.18736E+01	.70610E+00	-.80240E+00

X-STATION NO. 6 X=21.606 INTEGRATION STEP SIZE = .36300

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.70153E+00	.18806E+01	.80240E+00
2	-.18806E+01	.70153E+00	-.80240E+00

X-STATION NO. 7 X=21.957 INTEGRATION STEP SIZE = .36300

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 3.64000

VORTEX Y,VRTX Z,VRTX GAMMA/VINF

Figure 9.- Continued.

1	-.69747E+00	.18877E+01	.80240E+00
2	-.18877E+01	.69747E+00	-.80240E+00

X=STATION NO. 8 X=22.321 INTEGRATION STEP SIZE = .72600

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.69363E+00	.18953E+01	.80240E+00
2	-.18953E+01	.69363E+00	-.80240E+00

X=STATION NO. 9 X=22.685 INTEGRATION STEP SIZE = .72600

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.69017E+00	.19031E+01	.80240E+00
2	-.19031E+01	.69017E+00	-.80240E+00

X=STATION NO. 10 X=23.036 INTEGRATION STEP SIZE = .72600

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.68720E+00	.19109E+01	.80240E+00
2	-.19109E+01	.68720E+00	-.80240E+00

X=STATION NO. 11 X=23.400 INTEGRATION STEP SIZE = .72600

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.68451E+00	.19192E+01	.80240E+00
2	-.19192E+01	.68451E+00	-.80240E+00

CROSSFLOW VELOCITIES AT CONTROL POINTS INDUCED BY VORTICES AND THEIR IMAGES

IC	X,BODY	Y,BODY	Z,BODY	V	W
1	.21031E+02	.15310E+01	0.	.21494E-02	-.70848E-02
2	.22187E+02	.15310E+01	0.	.22417E-02	-.73904E-02
3	.23342E+02	.15310E+01	0.	.23375E-02	-.77102E-02
4	.21216E+02	.19987E+01	0.	.40063E-02	-.44570E-02
5	.22281E+02	.19987E+01	0.	.41696E-02	-.46394E-02
6	.23347E+02	.19987E+01	0.	.43342E-02	-.48258E-02
7	.21400E+02	.24604E+01	0.	.43372E-02	-.26581E-02

Figure 9.- Continued.

8	.22376E+02	.24664E+01	0.	.44995E-02	-.27581E-02
9	.23351E+02	.24664E+01	0.	.46627E-02	-.28607E-02
10	.21585E+02	.29340E+01	0.	.41198E-02	-.14995E-02
11	.22470E+02	.29340E+01	0.	.42595E-02	-.15510E-02
12	.23356E+02	.29340E+01	0.	.44001E-02	-.16042E-02
13	.21769E+02	.34016E+01	0.	.37321E-02	-.76368E-03
14	.22565E+02	.34016E+01	0.	.38456E-02	-.78743E-03
15	.23360E+02	.34016E+01	0.	.39599E-02	-.81237E-03
16	.21031E+02	-.15310E+01	0.	-.76760E-01	-.17026E+00
17	.22187E+02	-.15310E+01	0.	-.76729E-01	-.17591E+00
18	.23342E+02	-.15310E+01	0.	-.75708E-01	-.18067E+00
19	.21216E+02	-.19987E+01	0.	-.13321E+00	-.38546E-01
20	.22281E+02	-.19987E+01	0.	-.13885E+00	-.42546E-01
21	.23347E+02	-.19987E+01	0.	-.14371E+00	-.47503E-01
22	.21400E+02	-.24664E+01	0.	-.76287E-01	.33442E-01
23	.22376E+02	-.24664E+01	0.	-.80075E-01	.34808E-01
24	.23351E+02	-.24664E+01	0.	-.84175E-01	.35781E-01
25	.21585E+02	-.29340E+01	0.	-.32972E-01	.36466E-01
26	.22470E+02	-.29340E+01	0.	-.34252E-01	.37988E-01
27	.23356E+02	-.29340E+01	0.	-.35706E-01	.39482E-01
28	.21769E+02	-.34016E+01	0.	-.14196E-01	.27926E-01
29	.22565E+02	-.34016E+01	0.	-.14621E-01	.28902E-01
30	.23360E+02	-.34016E+01	0.	-.15118E-01	.29897E-01
31	.21031E+02	.73521E-13	.15310E+01	.17026E+00	.76760E-01
32	.22187E+02	.73521E-13	.15310E+01	.17591E+00	.76729E-01
33	.23342E+02	.73521E-13	.15310E+01	.18067E+00	.75708E-01
34	.21216E+02	.95983E-13	.19987E+01	.38546E-01	.13321E+00
35	.22281E+02	.95983E-13	.19987E+01	.42546E-01	.13885E+00
36	.23347E+02	.95983E-13	.19987E+01	.47503E-01	.14371E+00
37	.21400E+02	.11844E-12	.24664E+01	-.33442E-01	.76287E-01
38	.22376E+02	.11844E-12	.24664E+01	-.34808E-01	.80075E-01
39	.23351E+02	.11844E-12	.24664E+01	-.35781E-01	.84175E-01
40	.21585E+02	.14090E-12	.29340E+01	-.36466E-01	.32972E-01
41	.22470E+02	.14090E-12	.29340E+01	-.37988E-01	.34252E-01
42	.23356E+02	.14090E-12	.29340E+01	-.39482E-01	.35706E-01
43	.21769E+02	.16335E-12	.34016E+01	-.27926E-01	.14196E-01
44	.22565E+02	.16335E-12	.34016E+01	-.28902E-01	.14621E-01
45	.23360E+02	.16335E-12	.34016E+01	-.29897E-01	.15118E-01
46	.21031E+02	-.73521E-13	-.15310E+01	.70848E-02	-.21494E-02
47	.22187E+02	-.73521E-13	-.15310E+01	.73904E-02	-.22417E-02
48	.23342E+02	-.73521E-13	-.15310E+01	.77102E-02	-.23375E-02
49	.21216E+02	-.95983E-13	-.19987E+01	.44570E-02	-.40063E-02
50	.22281E+02	-.95983E-13	-.19987E+01	.46394E-02	-.41696E-02
51	.23347E+02	-.95983E-13	-.19987E+01	.48258E-02	-.43342E-02
52	.21400E+02	-.11844E-12	-.24664E+01	.26581E-02	-.43372E-02
53	.22376E+02	-.11844E-12	-.24664E+01	.27581E-02	-.44995E-02
54	.23351E+02	-.11844E-12	-.24664E+01	.28607E-02	-.46627E-02
55	.21585E+02	-.14090E-12	-.29340E+01	.14995E-02	-.41198E-02
56	.22470E+02	-.14090E-12	-.29340E+01	.15510E-02	-.42595E-02
57	.23356E+02	-.14090E-12	-.29340E+01	.16042E-02	-.44001E-02
58	.21769E+02	-.16335E-12	-.34016E+01	.76368E-03	-.37321E-02
59	.22565E+02	-.16335E-12	-.34016E+01	.78743E-03	-.38456E-02
60	.23360E+02	-.16335E-12	-.34016E+01	.81237E-03	-.39599E-02
61	.20940E+02	.12505E+01	.24874E+00	.20095E-02	-.12229E-01
62	.20940E+02	.10601E+01	.70836E+00	.12919E-01	-.20885E-01
63	.20940E+02	.70836E+00	.10601E+01	.42643E-01	-.31116E-01
64	.20940E+02	.24874E+00	.12505E+01	.12866E+00	-.32286E-01
65	.20940E+02	-.24874E+00	.12505E+01	.32968E+00	.55337E-01
66	.20940E+02	-.70836E+00	.10601E+01	.16618E+00	.13512E+00
67	.20940E+02	-.10601E+01	.70836E+00	-.13512E+00	-.16618E+00
68	.20940E+02	-.12505E+01	.24874E+00	-.55337E-01	-.32968E+00
69	.20940E+02	-.12505E+01	-.24874E+00	.32286E-01	-.12866E+00
70	.20940E+02	-.10601E+01	-.70836E+00	.31116E-01	-.42643E-01
71	.20940E+02	-.70836E+00	-.10601E+01	.20885E-01	-.12919E-01
72	.20940E+02	-.24874E+00	-.12505E+01	.12229E-01	-.20095E-02

Figure 9.- Continued.

73	.20940E+02	.24874E+00	-.12505E+01	.58282E-02	.14082E-02
74	.20940E+02	.70836E+00	-.10601E+01	.13956E-02	.11524E-02
75	.20940E+02	.10601E+01	-.70836E+00	-.11524E-02	-.13956E-02
76	.20940E+02	.12505E+01	-.24874E+00	-.14082E-02	-.58282E-02
77	.22140E+02	.12505E+01	.24874E+00	.20985E-02	-.12770E-01
78	.22140E+02	.10601E+01	.70836E+00	.13486E-01	-.21799E-01
79	.22140E+02	.70836E+00	.10601E+01	.44448E-01	-.32424E-01
80	.22140E+02	.24874E+00	.12505E+01	.13321E+00	-.33330E-01
81	.22140E+02	-.24874E+00	.12505E+01	.32996E+00	.56340E-01
82	.22140E+02	-.70836E+00	.10601E+01	.15939E+00	.12975E+00
83	.22140E+02	-.10601E+01	.70836E+00	-.12975E+00	-.15939E+00
84	.22140E+02	-.12505E+01	.24874E+00	-.56340E-01	-.32996E+00
85	.22140E+02	-.12505E+01	-.24874E+00	.33330E-01	-.13321E+00
86	.22140E+02	-.10601E+01	-.70836E+00	.32424E-01	-.44448E-01
87	.22140E+02	-.70836E+00	-.10601E+01	.21799E-01	-.13486E-01
88	.22140E+02	-.24874E+00	-.12505E+01	.12770E-01	-.20985E-02
89	.22140E+02	.24874E+00	-.12505E+01	.60864E-02	.14706E-02
90	.22140E+02	.70836E+00	-.10601E+01	.14575E-02	.12035E-02
91	.22140E+02	.10601E+01	-.70836E+00	-.12035E-02	-.14575E-02
92	.22140E+02	.12505E+01	-.24874E+00	-.14706E-02	-.60864E-02
93	.23340E+02	.12505E+01	.24874E+00	.21926E-02	-.13340E-01
94	.23340E+02	.10601E+01	.70836E+00	.14077E-01	-.22751E-01
95	.23340E+02	.70836E+00	.10601E+01	.46275E-01	-.33741E-01
96	.23340E+02	.24874E+00	.12505E+01	.13737E+00	-.34239E-01
97	.23340E+02	-.24874E+00	.12505E+01	.32742E+00	.56877E-01
98	.23340E+02	-.70836E+00	.10601E+01	.15241E+00	.12413E+00
99	.23340E+02	-.10601E+01	.70836E+00	-.12413E+00	-.15241E+00
100	.23340E+02	-.12505E+01	.24874E+00	-.56877E-01	-.32742E+00
101	.23340E+02	-.12505E+01	-.24874E+00	.34239E-01	-.13737E+00
102	.23340E+02	-.10601E+01	-.70836E+00	.33741E-01	-.46275E-01
103	.23340E+02	-.70836E+00	-.10601E+01	.22751E-01	-.14077E-01
104	.23340E+02	-.24874E+00	-.12505E+01	.13340E-01	-.21926E-02
105	.23340E+02	.24874E+00	-.12505E+01	.63609E-02	.15369E-02
106	.23340E+02	.70836E+00	-.10601E+01	.15235E-02	.12579E-02
107	.23340E+02	.10601E+01	-.70836E+00	-.12579E-02	-.15235E-02
108	.23340E+02	.12505E+01	-.24874E+00	-.15369E-02	-.63609E-02

Figure 9.- Concluded.

```
NASA/LANGLEY WING-TAIL INTERFERENCE MODEL,UPWT PROJ.1124,CONFIGURATION B1W4,
$INPUT
CRP     = .36E+01,
SWLEP   = .3E+02,
SWTEP   = 0.0,
NCW     = 3,
MSWR    = 5,
MSWL    = 5,
ALFAC   = .14216E+02,
PHI     = .45E+02,
B2      = .234E+01,
FMACH   = .17E+01,
LVSWP   = 0,
FAC     = .95E+00,
NEVNPR  = 0,
TOLFAC  = .1E+01,
MSWU    = 5,
MSWD    = 5,
SWLEV   = .3E+02,
SWTEV   = 0.0,
CRPV    = .36E+01,
B2V     = .234E+01,
NCRX    = 1,
RB      = .13E+01,
RA      = .13E+01,
ERATIO  = .1E+01,
NBDCR   = 16,
DELR    = 0.0,
DELL    = 0.0,
DELU    = 0.0,
DELD    = 0.0,
SREF    = .550920E+01,
REFL    = .269E+01,
PHIDIH  = 0.0,
THETIT  = 0.0,
XWLE    = .198E+02,
NOLINP  = 1,
NOUT    = 0,
NPR     = 0,
NDRAG   = 1,
NVRTX   = 0,
NPRESS  = 0,
VRTMAX  = .5E+00,
NCWB    = 3,
NAGAIN  = 0,
BIL     = .36E+01,
ITAIL   = 0,
NVRTPL  = 0,
NBDYPR  = 1,
NTPR    = 0,
NTDAT   = 1,
NCWT    = 8,
NCPOUT  = 0,
NVLIN   = 1,
XSTART  = 0.0,
JCPT    = 0,
FKLE    = .5E+00,
FKSE    = .5E+00,
XM      = .195E+02,
ZM      = 0.0,
$END
```

Figure 10.- Output of program DEMON2, first sample case, step 3.

WING GEOMETRY

TIP CHORD = 2.24900

ROOT CHORD = 3.60000

WING SEMISPAN = 2.34000

LEADING EDGE SWEEP = 30.00000 DEGREES

TRAILING EDGE SWEEP = 0.00000 DEGREES

FLOW CONDITIONS

MACH = 1.70000 ALPHAC= 14.21600 PHI = 45.00000 ALFA = 10.00010 BETA = 10.00010

CRPT = 3.60000
CRPTV = 3.60000

WING THICKNESS INPUT DATA

SPANWISE LOCATIONS OF PANEL SIDE EDGES AND SWEEP ANGLES
OF WING SECTION TO THE LEFT

I	SPANWISE LOCATION FEET	LE SWEEP DEGREES	TE SWEEP DEGREES

RIGHT WING SURFACE

1	1.30000	0.00000	0.00000
2	1.76800	30.00000	0.00000
3	2.23600	30.00000	0.00000
4	2.70400	30.00000	0.00000
5	3.17200	30.00000	0.00000
6	3.64000	30.00000	0.00000

40 THICKNESS PANELS ARE TO BE LAID OUT
5 CHORDWISE ROWS WITH 8 IN EACH ROW

UPPER WING SURFACE

1	1.30000	0.00000	0.00000
2	1.76800	30.00000	0.00000
3	2.23600	30.00000	0.00000
4	2.70400	30.00000	0.00000
5	3.17200	30.00000	0.00000
6	3.64000	30.00000	0.00000

40 THICKNESS PANELS ARE TO BE LAID OUT
5 CHORDWISE ROWS WITH 8 IN EACH ROW

Figure 10.- Continued.

INPUT VALUES OF THE LOCAL SURFACE SLOPE OF THE THICKNESS DISTRIBUTION., FOR EACH CHORDWISE ROW THE FIRST VALUE IS FOR THE PANEL NEAREST THE LEADING EDGE

RIGHT WING SURFACE

ROW	SLOPES							
1	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
2	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
3	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
4	.12200	.12200	0.00000	0.00000	0.00000	0.00000	-.14100	-.14100
5	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100

UPPER WING SURFACE

ROW	SLOPES							
1	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
2	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
3	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
4	.12200	.12200	0.00000	0.00000	0.00000	0.00000	-.14100	-.14100
5	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100

```
$BODY

NXBODY  = 39,

LNOSE   = .78E+01,

LBODY   = .39E+02,

BCODE   = 2,

$END
```

PHYSICAL DIMENSIONS OF BODY AND LINE SINGULARITY STRENGTHS REPRESENTING THE BODY AT MACH= 1.7000 ALFAC= 14.2160

	X	R	DR/DX	TX	T(I)	TC(I)
1	0.0000	-.42633E-13	.34286	.58610E-13	.10092	.39465E-01
2	1.0263	.32639	.29353	.57761	-.40121E-01	-.10955E-01
3	2.0526	.60316	.24611	1.2234	-.25012E-01	-.62846E-02
4	3.0789	.63207	.20020	1.9350	-.23274E-01	-.81381E-02
5	4.1053	1.0145	.15547	2.7106	-.18881E-01	-.74517E-02
6	5.1316	1.1515	.11164	3.5485	-.15477E-01	-.75496E-02
7	6.1579	1.2439	.68439E-01	4.4479	-.11952E-01	-.73645E-02
8	7.1842	1.2921	.25613E-01	5.4078	-.83169E-02	-.70718E-02
9	8.2105	1.3000	0.	6.4233	.31078E-01	-.28112E-02
10	9.2368	1.3000	0.	7.4496	.35293E-02	.47755E-02
11	10.2632	1.3000	0.	8.4760	.34046E-02	.39930E-02
12	11.2895	1.3000	0.	9.5023	.14132E-02	.36673E-02
13	12.3158	1.3000	0.	10.529	.93969E-03	.26432E-02
14	13.3421	1.3000	0.	11.555	.55466E-03	.17866E-02
15	14.3684	1.3000	0.	12.581	.36257E-03	.10708E-02
16	15.3947	1.3000	0.	13.608	.23850E-03	.54355E-03
17	16.4211	1.3000	0.	14.634	.16227E-03	.22980E-03
18	17.4474	1.3000	0.	15.660	.11249E-03	.33410E-04

Figure 10.- Continued.

19	18.4737	1.3000	0.	16.686	.79559E-04	-.67235E-04
20	19.5000	1.3000	0.	17.713	.57218E-04	-.11629E-03
21	20.5263	1.3000	0.	18.739	.41794E-04	-.10983E-03
22	21.5526	1.3000	0.	19.765	.30961E-04	-.95708E-04
23	22.5789	1.3000	0.	20.792	.23236E-04	-.75192E-04
24	23.6053	1.3000	0.	21.818	.17650E-04	-.54633E-04
25	24.6316	1.3000	0.	22.844	.13558E-04	-.37078E-04
26	25.6579	1.3000	0.	23.871	.10525E-04	-.23532E-04
27	26.6842	1.3000	0.	24.897	.82509E-05	-.13875E-04
28	27.7105	1.3000	0.	25.923	.65280E-05	-.74713E-05
29	28.7368	1.3000	0.	26.950	.52100E-05	-.35327E-05
30	29.7632	1.3000	0.	27.976	.41922E-05	-.13202E-05
31	30.7895	1.3000	0.	29.002	.33993E-05	-.22844E-06
32	31.8158	1.3000	0.	30.029	.27766E-05	.19378E-06
33	32.8421	1.3000	0.	31.055	.22835E-05	.25675E-06
34	33.8684	1.3000	0.	32.081	.18903E-05	.15784E-06
35	34.8947	1.3000	0.	33.108	.15745E-05	.11691E-07
36	35.9211	1.3000	0.	34.134	.13191E-05	-.12295E-06
37	36.9474	1.3000	0.	35.160	.11112E-05	-.22221E-06
38	37.9737	1.3000	0.	36.186	.94102E-06	-.28188E-06
39	39.0000	1.3000	0.	37.213	0.	0.

PRESSURE COEFFICIENTS AT POINTS ON BODY MERIDIANS

BODY RING= 1

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.
1	11.25000	.51316	.16626	.03307	-.20308	.36619	.16431	.40615	.31470	.31793	1.63664	1.82164
2	22.50000	.51316	.15662	.06487	-.18468	.28906	.22763	.36935	.24369	.31793	1.49299	1.74720
3	33.75000	.51316	.14095	.09418	-.16471	.20227	.26242	.32942	.18128	.31793	1.36673	1.66642
4	45.00000	.51316	.11987	.11987	-.14395	.11616	.26874	.28789	.13035	.31793	1.26371	1.58241
5	56.25000	.51316	.09418	.14095	-.12318	.04000	.25033	.24637	.09186	.31793	1.18583	1.49840
6	67.50000	.51316	.06487	.15662	-.10322	-.01932	.21384	.20644	.06525	.31793	1.13200	1.41762
7	78.75000	.51316	.03307	.16626	-.08482	-.05811	.16768	.16964	.04898	.31793	1.09908	1.34318
8	90.00000	.51316	-.00000	.16952	-.06869	-.07629	.12065	.13738	.04083	.31793	1.08261	1.27792
9	101.25000	.51316	-.03307	.16626	-.05545	-.07713	.08050	.11091	.03828	.31793	1.07744	1.22437
10	112.50000	.51316	-.06487	.15662	-.04562	-.06654	.05275	.09124	.03876	.31793	1.07842	1.18458
11	123.75000	.51316	-.09418	.14095	-.03956	-.05195	.03986	.07913	.04007	.31793	1.08107	1.16007
12	135.00000	.51316	-.11987	.11987	-.03752	-.04093	.04093	.07504	.04069	.31793	1.08232	1.15180
13	146.25000	.51316	-.14095	.09418	-.03956	-.03986	.05195	.07913	.04007	.31793	1.08107	1.16007
14	157.50000	.51316	-.15662	.06487	-.04562	-.05275	.06654	.09124	.03876	.31793	1.07842	1.18458
15	168.75000	.51316	-.16626	.03307	-.05545	-.08050	.07713	.11091	.03828	.31793	1.07744	1.22437
16	180.00000	.51316	-.16952	-.00000	-.06869	-.12065	.07629	.13738	.04083	.31793	1.08261	1.27792
17	191.25000	.51316	-.16626	-.03307	-.08482	-.16768	.05811	.16964	.04898	.31793	1.09908	1.34318
18	202.50000	.51316	-.15662	-.06487	-.10322	-.21384	.01932	.20644	.06525	.31793	1.13200	1.41762
19	213.75000	.51316	-.14095	-.09418	-.12318	-.25033	-.04000	.24637	.09186	.31793	1.18583	1.49840
20	225.00000	.51316	-.11987	-.11987	-.14395	-.26874	-.11616	.28789	.13035	.31793	1.26371	1.58241
21	236.25000	.51316	-.09418	-.14095	-.16471	-.26242	-.20227	.32942	.18128	.31793	1.36673	1.66642
22	247.50000	.51316	-.06487	-.15662	-.18468	-.22763	-.28906	.36935	.24369	.31793	1.49299	1.74720
23	258.75000	.51316	-.03307	-.16626	-.20308	-.16431	-.36619	.40615	.31470	.31793	1.63664	1.82164
24	270.00000	.51316	.00000	-.16952	-.21920	-.07629	-.42368	.43841	.38919	.31793	1.78734	1.88690

Figure 10.- Continued.

25	281.25000	.51316	.03307	-.16626	-.23244	.02907	-.45337	.46488	.46006	.31793	1.93070	1.94045
26	292.50000	.51316	.06487	-.15662	-.24227	.14177	-.45015	.48455	.51904	.31793	2.05002	1.98024
27	303.75000	.51316	.09418	-.14095	-.24833	.25047	-.41274	.49666	.55827	.31793	2.12939	2.00475
28	315.00000	.51316	.11987	-.11987	-.25038	.34397	-.34397	.50075	.57205	.31793	2.15725	2.01302
29	326.25000	.51316	.14095	-.09418	-.24833	.41274	-.25047	.49666	.55827	.31793	2.12939	2.00475
30	337.50000	.51316	.15662	-.06487	-.24227	.45015	-.14177	.48455	.51904	.31793	2.05002	1.98024
31	348.75000	.51316	.16626	-.03307	-.23244	.45337	-.02907	.46488	.46006	.31793	1.93070	1.94045
32	360.00000	.51316	.16952	.00000	-.21920	.42368	.07629	.43841	.38919	.31793	1.78734	1.88690

BODY/WING= 2

1	11.25000	2.56579	.70961	.14115	-.14124	.29958	.18203	.28247	.19422	.22298	1.39291	1.57144
2	22.50000	2.56579	.66843	.27687	-.12479	.21696	.23429	.24959	.12886	.22298	1.26069	1.50491
3	33.75000	2.56579	.60157	.40196	-.10695	.12713	.25530	.21390	.07368	.22298	1.14905	1.43273
4	45.00000	2.56579	.51160	.51160	-.08840	.04161	.24586	.17679	.03113	.22298	1.06297	1.35766
5	56.25000	2.56579	.40196	.60157	-.06984	-.02944	.21090	.13969	.00171	.22298	1.00347	1.28258
6	67.50000	2.56579	.27687	.66843	-.05200	-.07871	.15864	.10400	-.01550	.22298	.96864	1.21040
7	78.75000	2.56579	.14115	.70961	-.03556	-.10271	.09915	.07112	-.02244	.22298	.95460	1.14387
8	90.00000	2.56579	-.00000	.72351	-.02115	-.10212	.04282	.04229	-.02170	.22298	.95609	1.08556
9	101.25000	2.56579	-.14115	.70961	-.00932	-.08155	-.00133	.01864	-.01633	.22298	.96695	1.03770
10	112.50000	2.56579	-.27687	.66843	-.00053	-.04863	-.02703	.00106	-.00950	.22298	.98077	1.00214
11	123.75000	2.56579	-.40196	.60157	.00488	-.01272	-.03168	-.00977	-.00406	.22298	.99179	.98024
12	135.00000	2.56579	-.51160	.51160	.00671	.01671	-.01671	-.01342	-.00200	.22298	.99595	.97285
13	146.25000	2.56579	-.60157	.40196	.00488	.03168	.01272	-.00977	-.00406	.22298	.99179	.98024
14	157.50000	2.56579	-.66843	.27687	-.00053	.02703	.04863	.00106	-.00950	.22298	.98077	1.00214
15	168.75000	2.56579	-.70961	.14115	-.00932	.00133	.08155	.01864	-.01633	.22298	.96695	1.03770
16	180.00000	2.56579	-.72351	-.00000	-.02115	-.04282	.10212	.04229	-.02170	.22298	.95609	1.08556
17	191.25000	2.56579	-.70961	-.14115	-.03556	-.09915	.10271	.07112	-.02244	.22298	.95460	1.14387
18	202.50000	2.56579	-.66843	-.27687	-.05200	-.15864	.07871	.10400	-.01550	.22298	.96864	1.21040
19	213.75000	2.56579	-.60157	-.40196	-.06984	-.21090	.02944	.13969	.00171	.22298	1.00347	1.28258
20	225.00000	2.56579	-.51160	-.51160	-.08840	-.24586	-.04161	.17679	.03113	.22298	1.06297	1.35766
21	236.25000	2.56579	-.40196	-.60157	-.10695	-.25530	-.12713	.21390	.07368	.22298	1.14905	1.43273
22	247.50000	2.56579	-.27687	-.66843	-.12479	-.23429	-.21696	.24959	.12886	.22298	1.26069	1.50491
23	258.75000	2.56579	-.14115	-.70961	-.14124	-.18203	-.29958	.28247	.19422	.22298	1.39291	1.57144
24	270.00000	2.56579	.00000	-.72351	-.15565	-.10212	-.36372	.31130	.26490	.22298	1.53589	1.62975
25	281.25000	2.56579	.14115	-.70961	-.16748	-.00223	-.40006	.33495	.33372	.22298	1.67511	1.67761
26	292.50000	2.56579	.27687	-.66843	-.17627	.10695	-.40263	.35253	.39199	.22298	1.79299	1.71317
27	303.75000	2.56579	.40196	-.60157	-.18168	.21315	-.36971	.36335	.43119	.22298	1.87230	1.73507
28	315.00000	2.56579	.51160	-.51160	-.18350	.30418	-.30418	.36701	.44503	.22298	1.90030	1.74246
29	326.25000	2.56579	.60157	-.40196	-.18168	.36971	-.21315	.36335	.43119	.22298	1.87230	1.73507
30	337.50000	2.56579	.66843	-.27687	-.17627	.40263	-.10695	.35253	.39199	.22298	1.79299	1.71317
31	348.75000	2.56579	.70961	-.14115	-.16748	.40006	.00223	.33495	.33372	.22298	1.67511	1.67761
32	360.00000	2.56579	.72351	.00000	-.15565	.36372	.10212	.31130	.26490	.22298	1.53589	1.62975

BODY RING= 3

1	11.25000	4.61842	1.06771	.21238	-.08033	.22574	.20086	.16066	.06989	.13346	1.14139	1.32501
2	22.50000	4.61842	1.00576	.41660	-.06680	.13775	.24102	.13359	.01221	.13346	1.02471	1.27026
3	33.75000	4.61842	.90516	.60481	-.05211	.04519	.24720	.10423	-.03411	.13346	.93100	1.21085
4	45.00000	4.61842	.76977	.76977	-.03684	-.03919	.22098	.07369	-.06712	.13346	.86423	1.14907
5	56.25000	4.61842	.60481	.90516	-.02157	-.10436	.16857	.04315	-.08669	.13346	.82463	1.08729
6	67.50000	4.61842	.41660	1.00576	-.00689	-.14264	.09977	.01378	-.09400	.13346	.80985	1.02788
7	78.75000	4.61842	.21238	1.06771	.00664	-.15070	.02641	-.01328	-.09112	.13346	.81567	.97313
8	90.00000	4.61842	-.00000	1.08863	.01850	-.13008	-.03951	-.03701	-.08092	.13346	.83630	.92514
9	101.25000	4.61842	-.21238	1.06771	.02824	-.08677	-.08768	-.05647	-.06693	.13346	.86461	.88575
10	112.50000	4.61842	-.41660	1.00576	.03547	-.03020	-.11104	-.07094	-.05303	.13346	.89273	.85649

Figure 10.- Continued.

11	123.75000	4.61842	-.60481	.90516	.03992	.02825	-.10687	-.07985	-.04289	.13346	.91324	.83847
12	135.00000	4.61842	-.76977	.76977	.04143	.07716	-.07716	-.08286	-.03918	.13346	.92075	.83238
13	146.25000	4.61842	-.90516	.60481	.03992	.10687	-.02825	-.07985	-.04289	.13346	.91324	.83847
14	157.50000	4.61842	-1.00576	.41660	.03547	.11104	.03020	-.07094	-.05303	.13346	.89273	.85649
15	168.75000	4.61842	-1.06771	.21238	.02824	.08768	.08677	-.05647	-.06693	.13346	.86461	.88575
16	180.00000	4.61842	-1.08863	-.00000	.01850	.03951	.13008	-.03701	-.08092	.13346	.83650	.92514
17	191.25000	4.61842	-1.06771	-.21238	.00644	-.02641	.15070	-.01328	-.09112	.13346	.81567	.97313
18	202.50000	4.61842	-1.00576	-.41660	-.00689	-.09977	.14264	.01378	-.09400	.13346	.80985	1.02788
19	213.75000	4.61842	-.90516	-.60481	-.02157	-.16857	.10436	.04315	-.08669	.13346	.82463	1.08729
20	225.00000	4.61842	-.76977	-.76977	-.03690	-.22098	.03919	.07369	-.04712	.13346	.86023	1.14907
21	236.25000	4.61842	-.60481	-.90516	-.05211	-.24720	-.04519	.10425	-.03411	.13346	.95100	1.21085
22	247.50000	4.61842	-.41660	-1.00576	-.06680	-.24102	-.13775	.13359	.01221	.13346	1.02471	1.27026
23	258.75000	4.61842	-.21238	-1.06771	-.08033	-.20086	-.22574	.16066	.06989	.13346	1.14139	1.32591
24	270.00000	4.61842	.00000	-1.08863	-.09219	-.13008	-.29660	.18438	.13453	.13346	1.27215	1.37300
25	281.25000	4.61842	.21238	-1.06771	-.10192	-.03661	-.33983	.20385	.19915	.13346	1.40288	1.41238
26	292.50000	4.61842	.41660	-1.00576	-.10916	.06818	-.34857	.21831	.25494	.13346	1.51574	1.44164
27	303.75000	4.61842	.60481	-.90516	-.11361	.17108	-.32064	.22722	.29296	.13346	1.59265	1.45967
28	315.00000	4.61842	.76977	-.76977	-.11511	.25895	-.25895	.23023	.30647	.13346	1.61998	1.46575
29	326.25000	4.61842	.90516	-.60481	-.11361	.32064	-.17108	.22722	.29296	.13346	1.59265	1.45967
30	337.50000	4.61842	1.00576	-.41660	-.10916	.34857	-.06818	.21831	.25494	.13346	1.51574	1.44164
31	348.75000	4.61842	1.06771	-.21238	-.10192	.33983	.03661	.20385	.19915	.13346	1.40288	1.41238
32	360.00000	4.61842	1.08863	.00000	-.09219	.29660	.13008	.18438	.13453	.13346	1.27215	1.37300

BODY RING= 4

1	11.25000	6.67105	1.24902	.24845	-.01697	.14328	.22303	.03594	-.06233	.04699	.87392	1.06867
2	22.50000	6.67105	1.17655	.48734	-.00804	.04966	.25004	.01608	-.10916	.04699	.77918	1.03254
3	33.75000	6.67105	1.05887	.70751	.00165	-.04565	.24017	-.00329	-.14409	.04699	.70850	.99334
4	45.00000	6.67105	.90049	.90049	.01172	-.12864	.19587	-.02345	-.16569	.04699	.66481	.95257
5	56.25000	6.67105	.70751	1.05887	.02180	-.18734	.12471	-.04360	-.17404	.04699	.64791	.91180
6	67.50000	6.67105	.48734	1.17655	.03149	-.21365	.03819	-.06298	-.17024	.04699	.65560	.87260
7	78.75000	6.67105	.24845	1.24902	.04042	-.20448	-.05002	-.08084	-.15623	.04699	.68394	.83647
8	90.00000	6.67105	-.00000	1.27349	.04825	-.16226	-.12618	-.09649	-.13495	.04699	.72699	.80480
9	101.25000	6.67105	-.24845	1.24902	.05467	-.09446	-.17860	-.10934	-.11043	.04699	.77659	.77881
10	112.50000	6.67105	-.48734	1.17655	.05944	-.01246	-.19939	-.11888	-.08758	.04699	.82282	.75950
11	123.75000	6.67105	-.70751	1.05887	.06238	.07024	-.18570	-.12476	-.07135	.04699	.85546	.74761
12	135.00000	6.67105	-.90049	.90049	.06337	.14011	-.14011	-.12675	-.06547	.04699	.86756	.74359
13	146.25000	6.67105	-1.05887	.70751	.06238	.18570	-.07024	-.12476	-.07135	.04699	.85566	.74761
14	157.50000	6.67105	-1.17655	.48734	.05944	.19939	.01246	-.11888	-.08758	.04699	.82282	.75950
15	168.75000	6.67105	-1.24902	.24845	.05467	.17860	.09446	-.10934	-.11043	.04699	.77659	.77881
16	180.00000	6.67105	-1.27349	-.00000	.04825	.12618	.16226	-.09649	-.13495	.04699	.72699	.80480
17	191.25000	6.67105	-1.24902	-.24845	.04042	.05002	.20448	-.08084	-.15623	.04699	.68394	.83647
18	202.50000	6.67105	-1.17655	-.48734	.03149	-.03819	.21365	-.06298	-.17024	.04699	.65560	.87260
19	213.75000	6.67105	-1.05887	-.70751	.02180	-.12471	.18734	-.04360	-.17404	.04699	.64791	.91180
20	225.00000	6.67105	-.90049	-.90049	.01172	-.19587	.12864	-.02345	-.16569	.04699	.66481	.95257
21	236.25000	6.67105	-.70751	-1.05887	.00165	-.24017	.04565	-.00329	-.14409	.04699	.70850	.99334
22	247.50000	6.67105	-.48734	-1.17655	-.00804	-.25004	-.04966	.01608	-.10916	.04699	.77918	1.03254
23	258.75000	6.67105	-.24845	-1.24902	-.01697	-.22303	-.14328	.03594	-.06233	.04699	.87392	1.06867
24	270.00000	6.67105	.00000	-1.27349	-.02480	-.16226	-.22127	.04960	-.00729	.04699	.98525	1.10034
25	281.25000	6.67105	.24845	-1.24902	-.03122	-.07591	-.27186	.06244	.04963	.04699	1.10040	1.12632
26	292.50000	6.67105	.48734	-1.17655	-.03600	.02393	-.28724	.07199	.09997	.04699	1.20223	1.14564
27	303.75000	6.67105	.70751	-1.05887	-.03893	.12307	-.26476	.07787	.13482	.04699	1.27274	1.15753
28	315.00000	6.67105	.90049	-.90049	-.03993	.20735	-.20735	.07985	.14730	.04699	1.29799	1.16154
29	326.25000	6.67105	1.05887	-.70751	-.03893	.26476	-.12307	.07787	.13482	.04699	1.27274	1.15753
30	337.50000	6.67105	1.17655	-.48734	-.03600	.28724	-.02393	.07199	.09997	.04699	1.20223	1.14564
31	348.75000	6.67105	1.24902	-.24845	-.03122	.27186	.07591	.06244	.04963	.04699	1.10040	1.12632
32	360.00000	6.67105	1.27349	.00000	-.02480	.22127	.16226	.04960	-.00729	.04699	.98525	1.10034

Figure 10.- Continued.

BODY RING= 5

BODY NOSE SEPARATION AT XB/RB = 5,52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = ,07510
VORTEX Y/RLOC (UNROLLED COORDS) = ,63291
VORTEX Z/RLOC (UNROLLED COORDS) = 1,17494

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = ,07510
RIGHT VORTEX Y(ROLLED COORDS,)/RLOC = -,38327
RIGHT VORTEX Z(ROLLED COORDS,)/RLOC = 1,27835
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -,07510
LEFT VORTEX Y(ROLLED COORDS,)/RLOC = -1,27835
LEFT VORTEX Z(ROLLED COORDS,)/RLOC = ,38327

1	11,25000	8,72368	1,27502	,25362	,01846	,09244	,24186	-,03692	-,13846	0,00000	,71989	,92531
2	22,50000	8,72368	1,20104	,49749	,02098	-,00455	,25906	-,04195	-,17259	0,00000	,65086	,91513
3	33,75000	8,72368	1,08091	,72224	,02371	-,09954	,23610	-,04742	-,19340	0,00000	,60875	,90407
4	45,00000	8,72368	,91924	,91924	,02655	-,17601	,17601	-,05310	-,19873	0,00000	,59797	,89257
5	56,25000	8,72368	,72224	1,08091	,02939	-,21820	,08758	-,05879	-,18674	0,00000	,62223	,88108
6	67,50000	8,72368	,49749	1,20104	,03213	-,21115	-,01531	-,06425	-,15486	0,00000	,68673	,87002
7	78,75000	8,72368	,25362	1,27502	,03464	-,13639	-,11342	-,06929	-,09967	0,00000	,79837	,85983
8	90,00000	8,72368	-,00000	1,30000	,03685	,03919	-,17544	-,07370	-,02991	0,00000	,93950	,85090
9	101,25000	8,72368	-,25362	1,27502	,03866	,31798	-,14709	-,07733	-,03667	0,00000	,92583	,84357
10	112,50000	8,72368	-,49749	1,20104	,04001	,37297	-,09363	-,08002	-,06200	0,00000	,87458	,83812
11	123,75000	8,72368	-,72224	1,08091	,04084	,23609	-,13492	-,08168	-,02545	0,00000	,94852	,83477
12	135,00000	8,72368	-,91924	,91924	,04112	,17544	-,17544	-,08224	-,02079	0,00000	,95795	,83364
13	146,25000	8,72368	-1,08091	,72224	,04084	,13492	-,23609	-,08168	-,02545	0,00000	,94852	,83477
14	157,50000	8,72368	-1,20104	,49749	,04001	,09363	-,37297	-,08002	-,06200	0,00000	,87458	,83812
15	168,75000	8,72368	-1,27502	,25362	,03866	,14709	-,31798	-,07733	-,03667	0,00000	,92583	,84357
16	180,00000	8,72368	-1,30000	-,00000	,03685	,17544	-,03919	-,07370	-,02991	0,00000	,93950	,85090
17	191,25000	8,72368	-1,27502	-,25362	,03464	,11342	,13639	-,06929	-,09967	0,00000	,79837	,85983
18	202,50000	8,72368	-1,20104	-,49749	,03213	,01531	,21115	-,06425	-,15486	0,00000	,68673	,87002
19	213,75000	8,72368	-1,08091	-,72224	,02939	-,08758	,21820	-,05879	-,18674	0,00000	,62223	,88108
20	225,00000	8,72368	-,91924	-,91924	,02655	-,17601	,17601	-,05310	-,19873	0,00000	,59797	,89257
21	236,25000	8,72368	-,72224	-1,08091	,02371	-,23610	,09954	-,04742	-,19340	0,00000	,60875	,90407
22	247,50000	8,72368	-,49749	-1,20104	,02098	-,25906	,00453	-,04195	-,17259	0,00000	,65086	,91513
23	258,75000	8,72368	-,25362	-1,27502	,01846	-,24186	-,09244	-,03692	-,13846	0,00000	,71989	,92531
24	270,00000	8,72368	,00000	-1,30000	,01625	-,18759	-,17544	-,03250	-,09467	0,00000	,80849	,93425
25	281,25000	8,72368	,25362	-1,27502	,01444	-,10489	-,23121	-,02888	-,04710	0,00000	,90472	,94157
26	292,50000	8,72368	,49749	-1,20104	,01309	-,00668	-,25088	-,02619	-,00372	0,00000	,99247	,94702
27	303,75000	8,72368	,72224	-1,08091	,01227	,09183	-,23132	-,02453	,02686	0,00000	1,05435	,95037
28	315,00000	8,72368	,91924	-,91924	,01199	,17544	-,17544	-,02397	,03792	0,00000	1,07671	,95151
29	326,25000	8,72368	1,08091	-,72224	,01227	,23132	-,09183	-,02453	,02686	0,00000	1,05435	,95037
30	337,50000	8,72368	1,20104	-,49749	,01309	,25088	,00668	-,02619	-,00372	0,00000	,99247	,94702
31	348,75000	8,72368	-1,27502	-,25362	,01444	,23121	,10489	-,02888	-,04710	0,00000	,90472	,94157
32	360,00000	8,72368	1,30000	,00000	,01625	,17544	,18759	-,03250	-,09467	0,00000	,80849	,93425

BODY RING= 6

BODY NOSE SEPARATION AT XB/RB = 5,52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = ,07701
VORTEX Y/RLOC (UNROLLED COORDS) = ,63679
VORTEX Z/RLOC (UNROLLED COORDS) = 1,22147

Figure 10.- Continued.

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= .07701
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.41343
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.31399
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.07701
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.31399
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .41343

1	11.25000	10.77632	1.27502	.25362	.01723	.09167	.24573	-.03446	-.13919	0.00000	.71841	.93030
2	22.50000	10.77632	1.20104	.49749	.01669	-.00614	.26294	-.03338	-.16925	0.00000	.65760	.93247
3	33.75000	10.77632	1.08091	.72224	.01611	-.10186	.23957	-.03222	-.18568	0.00000	.62437	.93482
4	45.00000	10.77632	.91924	.91924	.01550	-.17871	.17871	-.03101	-.18601	0.00000	.62371	.93727
5	56.25000	10.77632	.72224	1.08091	.01490	-.22080	.08932	-.02980	-.16797	0.00000	.66019	.93972
6	67.50000	10.77632	.49749	1.20104	.01432	-.21334	-.01441	-.02863	-.12865	0.00000	.73975	.94207
7	78.75000	10.77632	.25362	1.27502	.01378	-.13943	-.11281	-.02756	-.06501	0.00000	.86848	.94424
8	90.00000	10.77632	-.00000	1.30000	.01331	.02598	-.17544	-.02662	.01263	0.00000	1.02555	.94615
9	101.25000	10.77632	-.25362	1.27502	.01292	.27244	-.15615	-.02585	.02547	0.00000	1.05153	.94771
10	112.50000	10.77632	-.49749	1.20104	.01264	.34955	-.10333	-.02528	-.00024	0.00000	.99952	.94887
11	123.75000	10.77632	-.72224	1.08091	.01246	.24047	-.13199	-.02492	.03044	0.00000	1.06158	.94958
12	135.00000	10.77632	-.91924	.91924	.01240	.17544	-.17544	-.02480	.03706	0.00000	1.07497	.94982
13	146.25000	10.77632	-1.08091	.72224	.01246	.13199	-.24047	-.02492	.03044	0.00000	1.06158	.94958
14	157.50000	10.77632	-1.20104	.49749	.01264	.10333	-.34955	-.02528	-.00024	0.00000	.99952	.94887
15	168.75000	10.77632	-1.27502	.25362	.01292	.15615	-.27244	-.02585	.02547	0.00000	1.05153	.94771
16	180.00000	10.77632	-1.30000	-.00000	.01331	.17544	-.02598	-.02662	.01263	0.00000	1.02555	.94615
17	191.25000	10.77632	-1.27502	-.25362	.01378	.11281	.13943	-.02756	-.06501	0.00000	.86848	.94424
18	202.50000	10.77632	-1.20104	-.49749	.01432	.01441	.21334	-.02863	-.12865	0.00000	.73975	.94207
19	213.75000	10.77632	-1.08091	-.72224	.01490	-.08932	.22080	-.02980	-.16797	0.00000	.66019	.93972
20	225.00000	10.77632	-.91924	-.91924	.01550	-.17871	.17871	-.03101	-.18601	0.00000	.62371	.93727
21	236.25000	10.77632	-.72224	-1.08091	.01611	-.23957	.10186	-.03222	-.18568	0.00000	.62437	.93482
22	247.50000	10.77632	-.49749	-1.20104	.01669	-.26294	.00614	-.03338	-.16925	0.00000	.65760	.93247
23	258.75000	10.77632	-.25362	-1.27502	.01723	-.24573	-.09167	-.03446	-.13919	0.00000	.71841	.93030
24	270.00000	10.77632	.00000	-1.30000	.01770	-.19104	-.17544	-.03540	-.09925	0.00000	.79922	.92839
25	281.25000	10.77632	.25362	-1.27502	.01808	-.10759	-.23174	-.03617	-.05520	0.00000	.88833	.92683
26	292.50000	10.77632	.49749	-1.20104	.01837	-.00846	-.25162	-.03674	-.01473	0.00000	.97021	.92567
27	303.75000	10.77632	.72224	-1.08091	.01855	.09101	-.23186	-.03709	.01392	0.00000	1.02817	.92496
28	315.00000	10.77632	.91924	-.91924	.01861	.17544	-.17544	-.03721	.02430	0.00000	1.04915	.92472
29	326.25000	10.77632	1.08091	-.72224	.01855	.23186	-.09101	-.03709	.01392	0.00000	1.02817	.92496
30	337.50000	10.77632	1.20104	-.49749	.01837	.25162	.00846	-.03674	-.01473	0.00000	.97021	.92567
31	348.75000	10.77632	1.27502	-.25362	.01808	.23174	.10759	-.03617	-.05520	0.00000	.88833	.92683
32	360.00000	10.77632	1.30000	.00000	.01770	.17544	.19104	-.03540	-.09925	0.00000	.79922	.92839

BODY RING= 7

BODY NOSE SEPARATION AT XB/RB. = 5.52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .07891
VORTEX Y/RLOC (UNROLLED COORDS) = .64087
VORTEX Z/RLOC (UNROLLED COORDS) = 1.24800

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= .07891
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.44345
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.34977
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.07891
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.34977
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .44345

1	11.25000	12.82895	1.27502	.25362	.01336	.09328	.23765	-.02672	-.12754	0.00000	.74199	.94594
2	22.50000	12.82895	1.20104	.49749	.01226	-.00257	.25433	-.02452	-.15614	0.00000	.68412	.95039

Figure 10.- Continued.

3	33.75000	12.82895	1.08091	.72224	.01107	-.09622	.23113	-.02214	-.17124	0.00000	.65359	.95522
4	45.00000	12.82895	.91924	.91924	.00983	-.17112	.17112	-.01965	-.17022	0.00000	.65564	.96024
5	56.25000	12.82895	.72224	1.08091	.00858	-.21166	.08321	-.01717	-.15079	0.00000	.69495	.96527
6	67.50000	12.82895	.49749	1.20104	.00739	-.20346	-.01850	-.01478	-.11026	0.00000	.77695	.97010
7	78.75000	12.82895	.25362	1.27502	.00629	-.13127	-.11444	-.01258	-.04674	0.00000	.90544	.97455
8	90.00000	12.82895	-.00000	1.30000	.00533	.02363	-.17544	-.01065	.02799	0.00000	1.05663	.97845
9	101.25000	12.82895	-.25362	1.27502	.00454	.24321	-.16196	-.00907	.04810	0.00000	1.09731	.98165
10	112.50000	12.82895	-.49749	1.20104	.00395	.32994	-.11145	-.00790	.02477	0.00000	1.05012	.98403
11	123.75000	12.82895	-.72224	1.08091	.00359	.24358	-.12992	-.00717	.04813	0.00000	1.09736	.98549
12	135.00000	12.82895	-.91924	.91924	.00346	.17544	-.17544	-.00693	.05568	0.00000	1.11264	.98599
13	146.25000	12.82895	-1.08091	.72224	.00359	.12992	-.24358	-.00717	.04813	0.00000	1.09736	.98549
14	157.50000	12.82895	-1.20104	.49749	.00395	.11145	-.32994	-.00790	.02477	0.00000	1.05012	.98403
15	168.75000	12.82895	-1.27502	.25362	.00454	.16196	-.24321	-.00907	.04810	0.00000	1.09731	.98165
16	180.00000	12.82895	-1.30000	-.00000	.00533	.17544	-.02363	-.01065	.02799	0.00000	1.05663	.97845
17	191.25000	12.82895	-1.27502	-.25362	.00629	.11444	.13127	-.01258	-.04674	0.00000	.90544	.97455
18	202.50000	12.82895	-1.20104	-.49749	.00739	.01850	.20346	-.01478	-.11026	0.00000	.77695	.97010
19	213.75000	12.82895	-1.08091	-.72224	.00858	-.08321	.21166	-.01717	-.15079	0.00000	.69495	.96527
20	225.00000	12.82895	-.91924	-.91924	.00983	-.17112	.17112	-.01965	-.17022	0.00000	.65564	.96024
21	236.25000	12.82895	-.72224	-1.08091	.01107	-.23113	.09622	-.02214	-.17124	0.00000	.65359	.95522
22	247.50000	12.82895	-.49749	-1.20104	.01226	-.25433	.00257	-.02452	-.15614	0.00000	.68412	.95039
23	258.75000	12.82895	-.25362	-1.27502	.01336	-.23765	-.09328	-.02672	-.12754	0.00000	.74199	.94594
24	270.00000	12.82895	.00000	-1.30000	.01433	-.18411	-.17544	-.02865	-.08923	0.00000	.81948	.94204
25	281.25000	12.82895	.25362	-1.27502	.01512	-.10230	-.23069	-.03023	-.04694	0.00000	.90503	.93884
26	292.50000	12.82895	.49749	-1.20104	.01570	-.00504	-.25020	-.03141	-.00813	0.00000	.98356	.93646
27	303.75000	12.82895	.72224	-1.08091	.01607	.09257	-.23082	-.03213	.01932	0.00000	1.03909	.93499
28	315.00000	12.82895	.91924	-.91924	.01619	.17544	-.17544	-.03238	.02925	0.00000	1.05918	.93450
29	326.25000	12.82895	1.08091	-.72224	.01607	.23082	-.09257	-.03213	.01932	0.00000	1.03909	.93499
30	337.50000	12.82895	1.20104	-.49749	.01570	.25020	.00504	-.03141	-.00813	0.00000	.98356	.93646
31	348.75000	12.82895	1.27502	-.25362	.01512	.23069	.10230	-.03023	-.04694	0.00000	.90503	.93884
32	360.00000	12.82895	1.30000	.00000	.01433	.17544	.18411	-.02865	-.08923	0.00000	.81948	.94204

BODY RING= 8

BODY NOSE SEPARATION AT XB/RB = 5.52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .08082
VORTEX Y/RLOC (UNROLLED COORDS) = .64591
VORTEX Z/RLOC (UNROLLED COORDS) = 1.31453

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .08082
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.47279
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.38624
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.08082
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.38624
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .47279

1	11.25000	14.88158	1.27502	.25362	.00928	.09490	.22946	-.01855	-.11532	0.00000	.76670	.96207
2	22.50000	14.88158	1.20104	.49749	.00846	.00103	.24562	-.01691	-.14371	0.00000	.70927	.96579
3	33.75000	14.88158	1.08091	.72224	.00757	-.09054	.22262	-.01513	-.15873	0.00000	.67848	.96939
4	45.00000	14.88158	.91924	.91924	.00664	-.16351	.16351	-.01328	-.15776	0.00000	.68084	.97314
5	56.25000	14.88158	.72224	1.08091	.00571	-.20255	.07712	-.01143	-.13858	0.00000	.71965	.97689
6	67.50000	14.88158	.49749	1.20104	.00482	-.19377	-.02251	-.00964	-.09890	0.00000	.79993	.98049
7	78.75000	14.88158	.25362	1.27502	.00400	-.12339	-.11600	-.00800	-.03793	0.00000	.92326	.98381
8	90.00000	14.88158	-.00000	1.30000	.00328	.02217	-.17544	-.00656	.03169	0.00000	1.06410	.98672
9	101.25000	14.88158	-.25362	1.27502	.00269	.22012	-.16656	-.00538	.05492	0.00000	1.11111	.98911
10	112.50000	14.88158	-.49749	1.20104	.00225	.31040	-.11955	-.00451	.03517	0.00000	1.07114	.99089
11	123.75000	14.88158	-.72224	1.08091	.00198	.24356	-.12993	-.00397	.05147	0.00000	1.10412	.99198
12	135.00000	14.88158	-.91924	.91924	.00189	.17544	-.17544	-.00378	.05899	0.00000	1.11933	.99235

Figure 10.- Continued.

13	146.25000	14.88158	-1.08091	.72224	.00198	.12993	-.24356	-.00397	.05147	0.00000	1.10412	.99198
14	157.50000	14.88158	-1.20104	.49749	.00225	.11955	-.31040	-.00451	.03517	0.00000	1.07114	.99089
15	168.75000	14.88158	-1.27502	.25362	.00269	.16656	-.22012	-.00538	.05492	0.00000	1.11111	.98911
16	180.00000	14.88158	-1.30000	-.00000	.00328	.17544	-.02217	-.00656	.03169	0.00000	1.06410	.98672
17	191.25000	14.88158	-1.27502	-.25362	.00400	.11600	.12339	-.00800	-.03793	0.00000	.92326	.98381
18	202.50000	14.88158	-1.20104	-.49749	.00482	.02251	.19377	-.00964	-.09890	0.00000	.79993	.98049
19	213.75000	14.88158	-1.08091	-.72224	.00571	-.07712	.20255	-.01143	-.13858	0.00000	.71965	.97689
20	225.00000	14.88158	-.91924	-.91924	.00664	-.16351	.16351	-.01328	-.15776	0.00000	.68084	.97314
21	236.25000	14.88158	-.72224	-1.08091	.00757	-.22262	.09054	-.01513	-.15873	0.00000	.67888	.96939
22	247.50000	14.88158	-.49749	-1.20104	.00846	-.24562	-.00103	-.01691	-.14371	0.00000	.70927	.96579
23	258.75000	14.88158	-.25362	-1.27502	.00928	-.22946	-.09490	-.01855	-.11532	0.00000	.76670	.96247
24	270.00000	14.88158	.00000	-1.30000	.01000	-.17709	-.17544	-.01999	-.07743	0.00000	.84337	.95956
25	281.25000	14.88158	.25362	-1.27502	.01059	-.09693	-.22962	-.02117	-.03571	0.00000	.92775	.95717
26	292.50000	14.88158	.49749	-1.20104	.01102	-.00157	-.24877	-.02205	.00247	0.00000	1.00500	.95539
27	303.75000	14.88158	.72224	-1.08091	.01130	.09416	-.22976	-.02259	.02942	0.00000	1.05952	.95430
28	315.00000	14.88158	.91924	-.91924	.01139	.17544	-.17544	-.02277	.03916	0.00000	1.07922	.95393
29	326.25000	14.88158	1.08091	-.72224	.01130	.22976	-.09416	-.02259	.02942	0.00000	1.05952	.95430
30	337.50000	14.88158	1.20104	-.49749	.01102	.24877	.00157	-.02205	.00247	0.00000	1.00500	.95539
31	348.75000	14.88158	1.27502	-.25362	.01059	.22962	.09693	-.02117	-.03571	0.00000	.92775	.95717
32	360.00000	14.88158	1.30000	.00000	.01000	.17544	.17709	-.01999	-.07743	0.00000	.84337	.95956

BODY RING= 9

BODY NOSE SEPARATION AT XB/RB = 5.52485
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = .08272
VORTEX Y/RLOC (UNROLLED COORDS) = .65095
VORTEX Z/RLOC (UNROLLED COORDS) = 1.36106

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= .08272
RIGHT VORTEX Y(ROLLED COORDS.)/RLOC = -.50213
RIGHT VORTEX Z(ROLLED COORDS.)/RLOC = 1.42271
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -.08272
LEFT VORTEX Y(ROLLED COORDS.)/RLOC = -1.42271
LEFT VORTEX Z(ROLLED COORDS.)/RLOC = .50213

1	11.25000	16.93421	1.27502	.25362	.00617	.09596	.22413	-.01234	-.10656	0.00000	.78443	.97504
2	22.50000	16.93421	1.20104	.49749	.00572	.00339	.23992	-.01144	-.13511	0.00000	.72668	.97687
3	33.75000	16.93421	1.08091	.72224	.00523	-.08678	.21701	-.01046	-.15036	0.00000	.69582	.97884
4	45.00000	16.93421	.91924	.91924	.00472	-.15845	.15845	-.00944	-.14971	0.00000	.69714	.98090
5	56.25000	16.93421	.72224	1.08091	.00421	-.19647	.07306	-.00842	-.13103	0.00000	.73493	.98296
6	67.50000	16.93421	.49749	1.20104	.00372	-.18740	-.02515	-.00745	-.09241	0.00000	.81306	.98493
7	78.75000	16.93421	.25362	1.27502	.00327	-.11886	-.11690	-.00655	-.03396	0.00000	.93130	.98676
8	90.00000	16.93421	-.00000	1.30000	.00288	.01863	-.17544	-.00576	.03137	0.00000	1.06346	.98835
9	101.25000	16.93421	-.25362	1.27502	.00255	.19951	-.17066	-.00511	.05697	0.00000	1.11504	.98966
10	112.50000	16.93421	-.49749	1.20104	.00231	.29103	-.12757	-.00463	.04108	0.00000	1.08311	.99064
11	123.75000	16.93421	-.72224	1.08091	.00217	.24097	-.13166	-.00433	.05163	0.00000	1.10445	.99124
12	135.00000	16.93421	-.91924	.91924	.00212	.17544	-.17544	-.00423	.05852	0.00000	1.11838	.99144
13	146.25000	16.93421	-1.08091	.72224	.00217	.13166	-.24097	-.00433	.05163	0.00000	1.10445	.99124
14	157.50000	16.93421	-1.20104	.49749	.00231	.12757	-.29103	-.00463	.04108	0.00000	1.08311	.99064
15	168.75000	16.93421	-1.27502	.25362	.00255	.17066	-.19951	-.00511	.05697	0.00000	1.11504	.98966
16	180.00000	16.93421	-1.30000	-.00000	.00288	.17544	-.01863	-.00576	.03137	0.00000	1.06346	.98835
17	191.25000	16.93421	-1.27502	-.25362	.00327	.11690	.11886	-.00655	-.03396	0.00000	.93130	.98676
18	202.50000	16.93421	-1.20104	-.49749	.00372	.02515	.18740	-.00745	-.09241	0.00000	.81306	.98493
19	213.75000	16.93421	-1.08091	-.72224	.00421	-.07306	.19647	-.00842	-.13103	0.00000	.73493	.98296
20	225.00000	16.93421	-.91924	-.91924	.00472	-.15845	.15845	-.00944	-.14971	0.00000	.69714	.98090
21	236.25000	16.93421	-.72224	-1.08091	.00523	-.21701	.08678	-.01046	-.15036	0.00000	.69582	.97884
22	247.50000	16.93421	-.49749	-1.20104	.00572	-.23992	-.00339	-.01144	-.13511	0.00000	.72668	.97687

Figure 10.- Continued.

23	258,75000	16,93421	-,25362	-1,27502	,00617	-,22413	-,09596	-,01234	-,10656	0,00000	,78443	,97504
24	270,00000	16,93421	,00000	-1,30000	,00656	-,17254	-,17544	-,01313	-,06861	0,00000	,86120	,97345
25	281,25000	16,93421	,25362	-1,27502	,00689	-,09346	-,22893	-,01377	-,02695	0,00000	,94547	,97214
26	292,50000	16,93421	,49749	-1,20104	,00713	,00066	-,24784	-,01426	,01110	0,00000	1,02245	,97116
27	303,75000	16,93421	,72224	-1,08091	,00728	,09518	-,22908	-,01455	,03792	0,00000	1,07670	,97056
28	315,00000	16,93421	,91924	-,91924	,00733	,17544	-,17544	-,01465	,04760	0,00000	1,09629	,97036
29	326,25000	16,93421	1,08091	-,72224	,00728	,22908	-,09518	-,01455	,03792	0,00000	1,07670	,97056
30	337,50000	16,93421	1,20104	-,49749	,00713	,24784	-,00066	-,01426	,01110	0,00000	1,02245	,97116
31	348,75000	16,93421	1,27502	-,25362	,00689	,22893	,09346	-,01377	-,02695	0,00000	,94547	,97214
32	360,00000	16,93421	1,30000	,00000	,00656	,17544	,17254	-,01313	-,06861	0,00000	,86120	,97345

BODY RING= 10

BODY NOSE SEPARATION AT XB/RB = 5,52445
VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = ,08688
VORTEX Y/RLOC (UNROLLED COORDS) = ,65576
VORTEX Z/RLOC (UNROLLED COORDS) = 1,40759

RIGHT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF)= ,08688
RIGHT VORTEX Y(ROLLED COORDS,)/RLOC = -,53163
RIGHT VORTEX Z(ROLLED COORDS,)/RLOC = 1,45901
LEFT VORTEX STRENGTH GAMMA/(2*PI*RLOC*VINF) = -,08688
LEFT VORTEX Y(ROLLED COORDS,)/RLOC = -1,45901
LEFT VORTEX Z(ROLLED COORDS,)/RLOC = ,53163

1	11,25000	18,98684	1,27502	,25362	,00416	,09660	,22095	-,00832	-,10104	0,00000	,79560	,98318
2	22,50000	18,98684	1,20104	,49749	,00395	,00485	,23640	-,00791	-,12964	0,00000	,73774	,98401
3	33,75000	18,98684	1,08091	,72224	,00373	-,08436	,21339	-,00746	-,14494	0,00000	,70679	,98491
4	45,00000	18,98684	,91924	,91924	,00350	-,15498	,15498	-,00700	-,14430	0,00000	,70809	,98584
5	56,25000	18,98684	,72224	1,08091	,00327	-,19196	,07004	-,00653	-,12567	0,00000	,74577	,98678
6	67,50000	18,98684	,49749	1,20104	,00304	-,18211	-,02734	-,00609	-,08742	0,00000	,82315	,98768
7	78,75000	18,98684	,25362	1,27502	,00284	-,11411	-,11785	-,00568	-,03043	0,00000	,93804	,98851
8	90,00000	18,98684	-,00000	1,30000	,00266	,01843	-,17544	-,00532	,03175	0,00000	1,06423	,98924
9	101,25000	18,98684	-,25362	1,27502	,00251	,18801	-,17295	-,00503	,05746	0,00000	1,11625	,98983
10	112,50000	18,98684	-,49749	1,20104	,00240	,27961	-,13230	-,00481	,04404	0,00000	1,08910	,99028
11	123,75000	18,98684	-,72224	1,08091	,00234	,24039	-,13205	-,00467	,05139	0,00000	1,10397	,99055
12	135,00000	18,98684	-,91924	,91924	,00231	,17544	-,17544	-,00463	,05810	0,00000	1,11754	,99064
13	146,25000	18,98684	-1,08091	,72224	,00234	,13205	-,24039	-,00467	,05139	0,00000	1,10397	,99055
14	157,50000	18,98684	-1,20104	,49749	,00240	,13230	-,27961	-,00481	,04404	0,00000	1,08910	,99028
15	168,75000	18,98684	-1,27502	,25362	,00251	,17295	-,18801	-,00503	,05746	0,00000	1,11625	,98983
16	180,00000	18,98684	-1,30000	-,00000	,00266	,17544	-,01843	-,00532	,03175	0,00000	1,06423	,98924
17	191,25000	18,98684	-1,27502	-,25362	,00284	,11785	,11411	-,00568	-,03043	0,00000	,93804	,98851
18	202,50000	18,98684	-1,20104	-,49749	,00304	,02734	,18211	-,00609	-,08742	0,00000	,82315	,98768
19	213,75000	18,98684	-1,08091	-,72224	,00327	-,07004	,19196	-,00653	-,12567	0,00000	,74577	,98678
20	225,00000	18,98684	-,91924	-,91924	,00350	-,15498	,15498	-,00700	-,14430	0,00000	,70809	,98584
21	236,25000	18,98684	-,72224	-1,08091	,00373	-,21339	,08436	-,00746	-,14494	0,00000	,70679	,98491
22	247,50000	18,98684	-,49749	-1,20104	,00395	-,23640	-,00485	-,00791	-,12964	0,00000	,73774	,98401
23	258,75000	18,98684	-,25362	-1,27502	,00416	-,22095	-,09660	-,00832	-,10104	0,00000	,79560	,98318
24	270,00000	18,98684	,00000	-1,30000	,00434	-,16969	-,17544	-,00867	-,06304	0,00000	,87247	,98245
25	281,25000	18,98684	,25362	-1,27502	,00448	-,09147	-,22854	-,00897	-,02137	0,00000	,95677	,98185
26	292,50000	18,98684	,49749	-1,20104	,00459	,00193	-,24732	-,00919	,01666	0,00000	1,03371	,98141
27	303,75000	18,98684	,72224	-1,08091	,00466	,09575	-,22869	-,00932	,04345	0,00000	1,08790	,98114
28	315,00000	18,98684	,91924	-,91924	,00468	,17544	-,17544	-,00937	,05312	0,00000	1,10746	,98105
29	326,25000	18,98684	1,08091	-,72224	,00466	,22869	-,09575	-,00932	,04345	0,00000	1,08790	,98114

Figure 10.- Continued.

30	337.50000	18.98684	1.20104	-.49749	.00459	-.24732	-.00193	-.00919	.01666	0.00000	1.03371	.98141
31	348.75000	18.98684	1.27502	-.25362	.00448	.22854	.09147	-.00897	-.02137	0.00000	.95677	.98185
32	360.00000	18.98684	1.30000	.00000	.00434	.17544	.16969	-.00867	-.06304	0.00000	.87247	.98245

TOTAL NUMBER OF PRESSURE POINTS,JCPT= 320

POINT COORDINATES AND PERTURBATION VELOCITIES CALCULATED BY PROGRAM VPATHZ OR VPATHL

IC	XCP	YCP	ZCP	VVEL(IC)	WVEL(IC)
1	21.03100	1.53100	0.00000	.21494E-02	-.70848E-02
2	22.18700	1.53100	0.00000	.22417E-02	-.73904E-02
3	23.34200	1.53100	0.00000	.23375E-02	-.77102E-02
4	21.21600	1.99870	0.00000	.40063E-02	-.44570E-02
5	22.28100	1.99870	0.00000	.41696E-02	-.46394E-02
6	23.34700	1.99870	0.00000	.43342E-02	-.48259E-02
7	21.40000	2.46640	0.00000	.43372E-02	-.26581E-02
8	22.37600	2.46640	0.00000	.44995E-02	-.27581E-02
9	23.35100	2.46640	0.00000	.46627E-02	-.28607E-02
10	21.58500	2.93400	0.00000	.41198E-02	-.14995E-02
11	22.47000	2.93400	0.00000	.42595E-02	-.15510E-02
12	23.35600	2.93400	0.00000	.44001E-02	-.16042E-02
13	21.76900	3.40160	0.00000	.47321E-02	-.76368E-03
14	22.56500	3.40160	0.00000	.38456E-02	-.78743E-03
15	23.36000	3.40160	0.00000	.39599E-02	-.81257E-03
16	21.03100	-1.53100	0.00000	-.76760E-01	-.17026E+00
17	22.18700	-1.53100	0.00000	-.76729E-01	-.17591E+00
18	23.34200	-1.53100	0.00000	-.75708E-01	-.18067E+00
19	21.21600	-1.99870	0.00000	-.13321E+00	-.38546E-01
20	22.28100	-1.99870	0.00000	-.13885E+00	-.42546E-01
21	23.34700	-1.99870	0.00000	-.14371E+00	-.47503E-01
22	21.40000	-2.46640	0.00000	-.76287E-01	.33442E-01
23	22.37600	-2.46640	0.00000	-.80075E-01	.34808E-01
24	23.35100	-2.46640	0.00000	-.84175E-01	.35781E-01
25	21.58500	-2.93400	0.00000	-.32972E-01	.36466E-01
26	22.47000	-2.93400	0.00000	-.34252E-01	.37988E-01
27	23.35600	-2.93400	0.00000	-.35706E-01	.39482E-01
28	21.76900	-3.40160	0.00000	-.14196E-01	.27926E-01
29	22.56500	-3.40160	0.00000	-.14621E-01	.28902E-01
30	23.36000	-3.40160	0.00000	-.15118E-01	.29897E-01
31	21.03100	.00000	1.53100	.17026E+00	.76760E-01
32	22.18700	.00000	1.53100	.17591E+00	.76729E-01
33	23.34200	.00000	1.53100	.18067E+00	.75708E-01
34	21.21600	.00000	1.99870	.38546E-01	.13321E+00
35	22.28100	.00000	1.99870	.42546E-01	.13885E+00
36	23.34700	.00000	1.99870	.47503E-01	.14371E+00
37	21.40000	.00000	2.46640	-.33442E-01	.76287E-01
38	22.37600	.00000	2.46640	-.34808E-01	.80075E-01
39	23.35100	.00000	2.46640	-.35781E-01	.84175E-01
40	21.58500	.00000	2.93400	-.36466E-01	.32972E-01
41	22.47000	.00000	2.93400	-.37988E-01	.34252E-01
42	23.35600	.00000	2.93400	-.39482E-01	.35706E-01
43	21.76900	.00000	3.40160	-.27926E-01	.14196E-01
44	22.56500	.00000	3.40160	-.28902E-01	.14621E-01
45	23.36000	.00000	3.40160	-.29897E-01	.15118E-01
46	21.03100	-.00000	-1.53100	.70848E-02	-.21494E-02

Figure 10.- Continued.

47	22.18700	-.00000	-1.53100	.73904E-02	-.22417E-02
48	23.34200	-.00000	-1.53100	.77102E-02	-.23375E-02
49	21.21600	-.00000	-1.99870	.44570E-02	-.40063E-02
50	22.28100	-.00000	-1.99870	.46394E-02	-.41696E-02
51	23.34700	-.00000	-1.99870	.48258E-02	-.43342E-02
52	21.40000	-.00000	-2.46640	.26581E-02	-.43372E-02
53	22.37600	-.00000	-2.46640	.27581E-02	-.44495E-02
54	23.35100	-.00000	-2.46640	.28607E-02	-.44627E-02
55	21.58500	-.00000	-2.93400	.14995E-02	-.41198E-02
56	22.47000	-.00000	-2.93400	.15510E-02	-.42595E-02
57	23.35600	-.00000	-2.93400	.16042E-02	-.44001E-02
58	21.76900	-.00000	-3.40160	.76368E-03	-.37321E-02
59	22.56500	-.00000	-3.40160	.78743E-03	-.34456E-02
60	23.36000	-.00000	-3.40160	.81237E-03	-.39599E-02
61	20.94000	1.25050	.24874	.20095E-02	-.12229E-01
62	20.94000	1.06010	.70836	.12919E-01	-.20885E-01
63	20.94000	.70836	1.06010	.42643E-01	-.31116E-01
64	20.94000	.24874	1.25050	.12866E+00	-.32286E-01
65	20.94000	-.24874	1.25050	.32968E+00	.55337E-01
66	20.94000	-.70836	1.06010	.16618E+00	.13512E+00
67	20.94000	-1.06010	.70836	-.13512E+00	-.16618E+00
68	20.94000	-1.25050	.24874	-.55337E-01	-.32968E+00
69	20.94000	-1.25050	-.24874	.32286E-01	-.12866E+00
70	20.94000	-1.06010	-.70836	.31116E-01	-.42643E-01
71	20.94000	-.70836	-1.06010	.20885E-01	-.12919E-01
72	20.94000	-.24874	-1.25050	.12229E-01	-.20095E-02
73	20.94000	.24874	-1.25050	.58282E-02	.14082E-02
74	20.94000	.70836	-1.06010	.13956E-02	.11524E-02
75	20.94000	1.06010	-.70836	-.11524E-02	-.13956E-02
76	20.94000	1.25050	-.24874	-.14082E-02	-.58282E-02
77	22.14000	1.25050	.24874	.20985E-02	-.12770E-01
78	22.14000	1.06010	.70836	.13486E-01	-.21799E-01
79	22.14000	.70836	1.06010	.44448E-01	-.32424E-01
80	22.14000	.24874	1.25050	.13321E+00	-.33330E-01
81	22.14000	-.24874	1.25050	.32995E+00	.56340E-01
82	22.14000	-.70836	1.06010	.15939E+00	.12975E+00
83	22.14000	-1.06010	.70836	-.12975E+00	-.15939E+00
84	22.14000	-1.25050	.24874	-.56340E-01	-.32995E+00
85	22.14000	-1.25050	-.24874	.33330E-01	-.13321E+00
86	22.14000	-1.06010	-.70836	.32424E-01	-.44448E-01
87	22.14000	-.70836	-1.06010	.21799E-01	-.13486E-01
88	22.14000	-.24874	-1.25050	.12770E-01	-.20985E-02
89	22.14000	.24874	-1.25050	.60864E-02	.14706E-02
90	22.14000	.70836	-1.06010	.14575E-02	.12035E-02
91	22.14000	1.06010	-.70836	-.12035E-02	-.14575E-02
92	22.14000	1.25050	-.24874	-.14706E-02	-.60864E-02
93	23.34000	1.25050	.24874	.21926E-02	-.13340E-01
94	23.34000	1.06010	.70836	.14077E-01	-.22751E-01
95	23.34000	.70836	1.06010	.46275E-01	-.33741E-01
96	23.34000	.24874	1.25050	.13737E+00	-.34239E-01
97	23.34000	-.24874	1.25050	.32742E+00	.56877E-01
98	23.34000	-.70836	1.06010	.15241E+00	.12413E+00
99	23.34000	-1.06010	.70836	-.12413E+00	-.15241E+00
100	23.34000	-1.25050	.24874	-.56877E-01	-.32742E+00
101	23.34000	-1.25050	-.24874	.34239E-01	-.13737E+00
102	23.34000	-1.06010	-.70836	.33741E-01	-.46275E-01
103	23.34000	-.70836	-1.06010	.22751E-01	-.14077E-01
104	23.34000	-.24874	-1.25050	.13340E-01	-.21926E-02
105	23.34000	.24874	-1.25050	.63609E-02	.15369E-02

Figure 10.- Continued.

106	23.34000	.70836	-1.06010	.15235E-02	.12579E-02
107	23.34000	1.06010	-.70836	-.12579E-02	-.15235E-02
108	23.34000	1.25050	-.24874	-.15349E-02	-.63609E-02

CONTROL POINT COORDINATES FOR 5 CHORDWISE BY 5 SPANWISE PANELS ON WING 1 OR R, 5 SPANWISE ON WING 2 OR L
AND 5 SPANWISE PANELS ON WING 3 OR U, 5 SPANWISE ON WING 4 OR D

J	X(J)	Y(J)	Z(J)	BU(J)	BV(J)	BW(J)	VVRTX	WVRTX
1	1.23112	1.53096	0.00000	.30415E-02	.12608E+00	.12789E+00	0.	0.
2	2.38667	1.53096	0.00000	.25619E-02	.12617E+00	.12768E+00	0.	0.
3	3.54222	1.53096	0.00000	.22035E-02	.12622E+00	.12755E+00	0.	0.
4	1.41565	1.99870	0.00000	.30173E-02	.73266E-01	.75357E-01	0.	0.
5	2.48119	1.99870	0.00000	.25678E-02	.73453E-01	.75200E-01	0.	0.
6	3.54672	1.99870	0.00000	.22281E-02	.73581E-01	.75098E-01	0.	0.
7	1.60017	2.46640	0.00000	.30518E-02	.47405E-01	.49768E-01	0.	0.
8	2.57570	2.46640	0.00000	.26235E-02	.47650E-01	.49633E-01	0.	0.
9	3.55122	2.46640	0.00000	.22924E-02	.47827E-01	.49541E-01	0.	0.
10	1.78466	2.93403	0.00000	.31062E-02	.32808E-01	.35417E-01	0.	0.
11	2.67019	2.93403	0.00000	.26945E-02	.33091E-01	.35293E-01	0.	0.
12	3.55572	2.93403	0.00000	.23729E-02	.33299E-01	.35206E-01	0.	0.
13	1.96912	3.40158	0.00000	.32017E-02	.23701E-01	.26577E-01	0.	0.
14	2.76467	3.40158	0.00000	.28029E-02	.24011E-01	.26461E-01	0.	0.
15	3.56022	3.40158	0.00000	.24715E-02	.24266E-01	.26377E-01	0.	0.
16	1.23112	-1.53096	0.00000	.23353E-02	.12635E+00	.12789E+00	0.	0.
17	2.38667	-1.53096	0.00000	.21254E-02	.12638E+00	.12768E+00	0.	0.
18	3.54222	-1.53096	0.00000	.19174E-02	.12640E+00	.12755E+00	0.	0.
19	1.41565	-1.99870	0.00000	.22883E-02	.73972E-01	.75357E-01	0.	0.
20	2.48119	-1.99870	0.00000	.21091E-02	.74042E-01	.75200E-01	0.	0.
21	3.54672	-1.99870	0.00000	.19229E-02	.74077E-01	.75098E-01	0.	0.
22	1.60017	-2.46640	0.00000	.21980E-02	.48453E-01	.49768E-01	0.	0.
23	2.57570	-2.46640	0.00000	.20524E-02	.48538E-01	.49633E-01	0.	0.
24	3.55122	-2.46640	0.00000	.18969E-02	.48586E-01	.49541E-01	0.	0.
25	1.78466	-2.93403	0.00000	.21408E-02	.34196E-01	.35417E-01	0.	0.
26	2.67019	-2.93403	0.00000	.20174E-02	.34274E-01	.35293E-01	0.	0.
27	3.55572	-2.93403	0.00000	.18823E-02	.34317E-01	.35206E-01	0.	0.
28	1.96912	-3.40158	0.00000	.20349E-02	.25363E-01	.26577E-01	0.	0.
29	2.76467	-3.40158	0.00000	.19547E-02	.25464E-01	.26461E-01	0.	0.
30	3.56022	-3.40158	0.00000	.18804E-02	.25558E-01	.26377E-01	0.	0.
31	1.23112	0.00000	1.53096	.23353E-02	-.12789E+00	-.12635E+00	0.	0.
32	2.38667	0.00000	1.53096	.21254E-02	-.12768E+00	-.12638E+00	0.	0.
33	3.54222	0.00000	1.53096	.19174E-02	-.12755E+00	-.12640E+00	0.	0.
34	1.41565	0.00000	1.99870	.22883E-02	-.75357E-01	-.73972E-01	0.	0.
35	2.48119	0.00000	1.99870	.21091E-02	-.75200E-01	-.74042E-01	0.	0.
36	3.54672	0.00000	1.99870	.19229E-02	-.75098E-01	-.74077E-01	0.	0.
37	1.60017	0.00000	2.46640	.21980E-02	-.49768E-01	-.48453E-01	0.	0.
38	2.57570	0.00000	2.46640	.20524E-02	-.49633E-01	-.48538E-01	0.	0.
39	3.55122	0.00000	2.46640	.18969E-02	-.49541E-01	-.48586E-01	0.	0.
40	1.78466	0.00000	2.93403	.21408E-02	-.35417E-01	-.34196E-01	0.	0.
41	2.67019	0.00000	2.93403	.20174E-02	-.35293E-01	-.34274E-01	0.	0.
42	3.55572	0.00000	2.93403	.18823E-02	-.35206E-01	-.34317E-01	0.	0.
43	1.96912	0.00000	3.40158	.20349E-02	-.26577E-01	-.25363E-01	0.	0.
44	2.76467	0.00000	3.40158	.19547E-02	-.26461E-01	-.25464E-01	0.	0.
45	3.56022	0.00000	3.40158	.18804E-02	-.26377E-01	-.25558E-01	0.	0.
46	1.23112	0.00000	-1.53096	.30415E-02	-.12789E+00	-.12608E+00	0.	0.
47	2.38667	0.00000	-1.53096	.25619E-02	-.12768E+00	-.12617E+00	0.	0.
48	3.54222	0.00000	-1.53096	.22035E-02	-.12755E+00	-.12622E+00	0.	0.
49	1.41565	0.00000	-1.99870	.30173E-02	-.75357E-01	-.73266E-01	0.	0.
50	2.48119	0.00000	-1.99870	.25678E-02	-.75200E-01	-.73453E-01	0.	0.

Figure 10.- Continued.

51	3.54672	0.00000	-1.99870	.22281E-02	-.75098E-01	-.73581E-01	0.	
52	1.60017	0.00000	-2.46640	.30518E-02	-.49768E-01	-.47405E-01	0.	0.
53	2.57570	0.00000	-2.46640	.26235E-02	-.49633E-01	-.47650E-01	0.	0.
54	3.55122	0.00000	-2.46640	.22924E-02	-.49541E-01	-.47827E-01	0.	0.
55	1.78466	0.00000	-2.93403	.31062E-02	-.35417E-01	-.32808E-01	0.	0.
56	2.67019	0.00000	-2.93403	.26945E-02	-.35293E-01	-.33091E-01	0.	0.
57	3.55572	0.00000	-2.93403	.23729E-02	-.35206E-01	-.33299E-01	0.	0.
58	1.96912	0.00000	-3.40158	.32017E-02	-.26577E-01	-.23701E-01	0.	0.
59	2.76467	0.00000	-3.40158	.28029E-02	-.26461E-01	-.24011E-01	0.	0.
60	3.56022	0.00000	-3.40158	.24715E-02	-.26377E-01	-.24266E-01	0.	0.

CONTROL POINT COORDINATES FOR HIP-S (WING FRAME)

J	X(J)	Y(J)	Z(J)	THU(J)	THV(J)	THW(J)
61	1.14000	1.25052	.24874	-.13891E-02	-.18221E-01	.34655E-02
62	1.14000	1.06014	.70836	-.15717E-01	-.88792E-02	.20553E-01
63	1.14000	.70836	1.06014	-.15717E-01	.20553E-01	-.88792E-02
64	1.14000	.24874	1.25052	-.13891E-02	.34655E-02	-.18221E-01
65	1.14000	-.24874	1.25052	-.13891E-02	-.34655E-02	-.18221E-01
66	1.14000	-.70836	1.06014	-.15717E-01	-.20553E-01	-.88792E-02
67	1.14000	-1.06014	.70836	-.15717E-01	.88792E-02	.20553E-01
68	1.14000	-1.25052	.24874	-.13891E-02	.18221E-01	.34655E-02
69	1.14000	-1.25052	-.24874	-.13891E-02	.18221E-01	-.34655E-02
70	1.14000	-1.06014	-.70836	-.15717E-01	.88792E-02	-.20553E-01
71	1.14000	-.70836	-1.06014	-.15717E-01	-.20553E-01	.88792E-02
72	1.14000	-.24874	-1.25052	-.13891E-02	-.34655E-02	.18221E-01
73	1.14000	.24874	-1.25052	-.13891E-02	.34655E-02	.18221E-01
74	1.14000	.70836	-1.06014	-.15717E-01	.20553E-01	.88792E-02
75	1.14000	1.06014	-.70836	-.15717E-01	-.88792E-02	-.20553E-01
76	1.14000	1.25052	-.24874	-.13891E-02	-.18221E-01	-.34655E-02
77	2.34000	1.25052	.24874	-.10617E-01	-.85805E-02	-.48355E-02
78	2.34000	1.06014	.70836	-.22211E-01	-.16042E-01	.68216E-02
79	2.34000	.70836	1.06014	-.22211E-01	.68216E-02	-.16042E-01
80	2.34000	.24874	1.25052	-.10617E-01	.48355E-02	-.85805E-02
81	2.34000	-.24874	1.25052	-.10617E-01	.48355E-02	-.85805E-02
82	2.34000	-.70836	1.06014	-.22211E-01	-.68216E-02	-.16042E-01
83	2.34000	-1.06014	.70836	-.22211E-01	.16042E-01	.68216E-02
84	2.34000	-1.25052	.24874	-.10617E-01	.85805E-02	-.48355E-02
85	2.34000	-1.25052	-.24874	-.10617E-01	.85805E-02	.48355E-02
86	2.34000	-1.06014	-.70836	-.22211E-01	.16042E-01	-.68216E-02
87	2.34000	-.70836	-1.06014	-.22211E-01	-.68216E-02	.16042E-01
88	2.34000	-.24874	-1.25052	-.10617E-01	.48355E-02	.85805E-02
89	2.34000	.24874	-1.25052	-.10617E-01	-.48355E-02	.85805E-02
90	2.34000	.70836	-1.06014	-.22211E-01	.68216E-02	.16042E-01
91	2.54000	1.06014	-.70836	-.22211E-01	-.16042E-01	-.68216E-02
92	2.34000	1.25052	-.24874	-.10617E-01	-.85805E-02	.48355E-02
93	3.54000	1.25052	.24874	.20323E-01	.26782E-01	-.54507E-01
94	3.54000	1.06014	.70836	-.22241E-01	.11295E-01	.68311E-02
95	3.54000	.70836	1.06014	-.22241E-01	.68311E-02	.11295E-01
96	3.54000	.24874	1.25052	.20323E-01	-.54507E-01	.26782E-01
97	3.54000	-.24874	1.25052	.20323E-01	.54507E-01	.26782E-01
98	3.54000	-.70836	1.06014	-.22241E-01	-.68311E-02	.11295E-01
99	3.54000	-1.06014	.70836	-.22241E-01	-.11295E-01	.68311E-02
100	3.54000	-1.25052	.24874	.20323E-01	-.26782E-01	-.54507E-01
101	3.54000	-1.25052	-.24874	.20323E-01	-.26782E-01	.54507E-01
102	3.54000	-1.06014	-.70836	-.22241E-01	-.11295E-01	-.68311E-02
103	3.54000	-.70836	-1.06014	-.22241E-01	-.68311E-02	-.11295E-01

Figure 10.- Continued.

104	3.54000	-.24874	-1.25052	.20323E-01	.54507E-01	-.26782E-01
105	3.54000	.24874	-1.25052	.20323E-01	-.54507E-01	-.26782E-01
106	3.54000	.70836	-1.06014	-.22241E-01	.68311E-02	-.11295E-01
107	3.54000	1.06014	-.70836	-.22241E-01	.11295E-01	-.68311E-02
108	3.54000	1.25052	-.24874	.20323E-01	.26782E-01	.54507E-01

LOADING INFORMATION

```
          MACH NUMBER =   .17000E+01
      ANGLE OF ATTACK =   10.000 DEGREES
      SIDE SLIP ANGLE =   10.000 DEGREES
            WING AREA =   13.68666
       REFERENCE AREA =   5.30929
     REFERENCE LENGTH =   2.69000
 EXPOSED WING SPAN B  =   4.68000
  MOMENT CENTER;   XM =   19.50000
                   ZM =   0.00000
```

U/VINF TYPE LOADING PRESSURE

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
DEFL. ANGLE DEG. =		0.00000	0.00000	0.00000	0.00000	
CTHR =	.53916E-01	.14774E-01	.12184E-01	.12184E-01	.14774E-01	
CZ =	.14450E+01	.66234E+00	.55746E+00	0.	0.	.22517E+00
CY =	-.14450E+01	0.	0.	-.55746E+00	-.66234E+00	-.22517E+00
CM =	-.14587E+01	-.65426E+00	-.54950E+00	0.	0.	-.25492E+00
CLN =	.14587E+01	0.	0.	.54950E+00	.65426E+00	.25492E+00
CLL =	.14346E-13	-.57478E+00	.50518E+00	-.50518E+00	.57478E+00	.13507E-15

FOLLOWING ARE IN WIND-AXIS SYSTEM

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
CL =	.19942E+01	.45763E+00	.34511E+00	.34511E+00	.45763E+00	.30869E+00
CY-IND =	.66169E-12	.46834E+00	.39419E+00	-.39419E+00	-.46834E+00	.63509E-12
CDI =	.44957E+00	.10069E+00	.84992E-01	.84992E-01	.10069E+00	.78202E-01
CDI/CL**2 =	.11305E+00					
CM-IND =	-.20629E+01	-.46263E+00	-.38855E+00	-.38855E+00	-.46263E+00	-.36052E+00
CLN-IND =	-.61018E-12	-.30731E+00	-.50072E+00	.50072E+00	.30731E+00	-.56044E-12

NOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW IS SUPERSONIC

Figure 10.- Continued.

*******************RIGHT WING*********************

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMMET(I)	GAMMA,LE/VINF	XLE
1	.65476	.19397	0.00000	0.00000	.00070	0.00000	0.00000	0.00000	-.90825	0.00000	.13334
2	.85415	.18840	0.00000	0.00000	.00259	0.00000	0.00000	0.00000	.02601	0.00000	.40340
3	1.05402	.17267	0.00000	0.00000	.00225	0.00000	0.00000	0.00000	.07359	0.00000	.67342
4	1.25386	.14562	0.00000	0.00000	.00201	0.00000	0.00000	0.00000	.12655	0.00000	.94341
5	1.45367	.10212	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.20368	0.00000	1.21335
6	1.55556	0.00000							.47841		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = .62235E-02
SUMFT2 = .26698E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	.00311	.00055	3.64000	1.35100
2	2	.66667	.03528	.00681	3.64000	2.10067
3	3	1.00000	.04568	.01491	3.64000	2.85033

****T.E. FIN VORTEX INFO******

IVRT	GAMMA/VINF	Y,C.G.
1	.90779	3.23687

Figure 10.- Continued.

------------------- LEFT WING --------------------

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
7	-.65426	.12209	0.00000	0.00000	-.00401	0.00000	0.00000	0.00000	.57449	0.00000	.13334
8	-.85415	.14651	0.00000	0.00000	.00178	0.00000	0.00000	0.00000	.11159	0.00000	.40340
9	-1.05402	.15930	0.00000	0.00000	-.00165	0.00000	0.00000	0.00000	.05999	0.00000	.67342
10	-1.25386	.14379	0.00000	0.00000	-.00351	0.00000	0.00000	0.00000	-.07257	0.00000	.94341
11	-1.45367	.10337	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.18919	0.00000	1.21335
12	-1.55556	0.00000							-.48431		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = -.61037E-02
SUMFT2 = -.32174E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	-.00495	-.00088	-3.64000	1.35100
2	2	.66667	-.04691	-.00920	-3.64000	2.10067
3	3	1.00000	-.04946	-.01797	-3.64000	2.85033

*****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Y;C.G.
2	.17134	-1.93153
3	-.74554	-3.43010

Figure 10.- Continued.

********************UPPER WING********************

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*H)	CT*C/(2*H)	CZ1*C/(2*H)	CZTOT*C/(2*H)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
13	.65426	.12269	0.00000	0.00000	.00401	0.00000	0.00000	0.00000	-.57409	0.00000	.13330
14	.85015	.14651	0.00000	0.00000	-.00178	0.00000	0.00000	0.00000	-.11159	0.00000	.40340
15	1.05402	.15930	0.00000	0.00000	.00365	0.00000	0.00000	0.00000	-.05999	0.00000	.67342
16	1.25386	.14379	0.00000	0.00000	.00351	0.00000	0.00000	0.00000	.07257	0.00000	.94341
17	1.45367	.10357	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.18919	0.00000	1.21335
18	1.55556	0.00000							.48431		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = .61037E-02
SUMFT2 = .32174E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	4	.33333	.00495	.00088	3.64000	1.35100
2	5	.66667	.04691	.00920	3.64000	2.10067
3	6	1.00000	.04986	.01797	3.64000	2.85033

****T.E. FIN VORTEX INFO******

IVRT	GAMMA/VINF	Z.C.G.
4	-.17134	1.93153
5	.74554	3.43010

Figure 10.- Continued.

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
19	-.65426	.19397	0.00000	0.00000	-.00070	0.00000	0.00000	0.00000	.90825	0.00000	.13334
20	-.85415	.18840	0.00000	0.00000	-.00259	0.00000	0.00000	0.00000	-.02601	0.00000	.40340
21	-1.05402	.17267	0.00000	0.00000	-.00225	0.00000	0.00000	0.00000	-.07359	0.00000	.67342
22	-1.25386	.14562	0.00000	0.00000	-.00201	0.00000	0.00000	0.00000	-.12655	0.00000	.94341
23	-1.45367	.10212	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.20368	0.00000	1.21335
24	-1.55556	0.00000							-.47841		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = -.62235E-02
SUMFT2 = -.26698E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	7	.33333	-.00310	-.00055	-3.64000	1.35100
2	8	.66667	-.03528	-.00681	-3.64000	2.10067
3	9	1.00000	-.04568	-.01491	-3.64000	2.85033

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Z.C.G.
6	-.90779	-3.23687

VELOCITIES AND BERNOULLI PRESSURES AT CONTROL POINTS IMMEDIATELY ABOVE AND BELOW HORIZONTAL WING SURFACE

J	X(J)	Y(J)	Z(J)	UTOTA	VTOTA	WTOTA	PRESSA	UTOTB	VTOTB	WTOTB	PRESSB
1	1.231118	1.530959	0.000000	.146995	-.005464	-.173650	-.226794	-.182872	.194985	-.173650	.498202
2	2.386670	1.530959	0.000000	.124987	.074735	-.173650	-.178168	-.116691	.167834	-.173650	.331516
3	3.542222	1.530959	0.000000	.102488	.159554	-.314650	-.212304	-.071752	.200785	-.032650	.196546
4	1.415654	1.998701	0.000000	.248685	-.131702	-.173650	-.374805	-.107871	.074156	-.173650	.295550
5	2.481188	1.998701	0.000000	.129551	.026553	-.173650	-.193772	-.126751	.125204	-.173650	.352481

Figure 10.- Continued.

6	3.546723	1.998701	0.000000	.164537	.112876	-.314650	-.246240	-.050582	.154275	-.032650	.149361
7	1.600170	2.466397	0.000000	.174346	-.033659	-.173650	-.270827	-.176806	.169078	-.173650	.482705
8	2.575697	2.466397	0.000000	.165859	.003287	-.173650	-.251365	-.115665	.111646	-.173650	.323032
9	3.551224	2.466397	0.000000	.239154	.092494	-.314650	-.338894	.042893	.130264	-.032650	-.044916
10	1.784662	2.934030	0.000000	.178746	-.026607	-.173650	-.274891	-.157138	.167316	-.173650	.432284
11	2.670193	2.934030	0.000000	.197168	-.051134	-.173650	-.303190	-.083959	.057072	-.173650	.233814
12	3.555723	2.934030	0.000000	.118982	.031854	-.314650	-.190418	-.034274	.061348	-.032650	.099520
13	1.969121	3.401580	0.000000	.125277	.046599	-.173650	-.183220	-.172306	.218409	-.173650	.467925
14	2.764672	3.401580	0.000000	.090547	.022698	-.173650	-.151423	-.096299	.095385	-.173650	.277790
15	3.560222	3.401580	0.000000	.212661	-.059834	-.314650	-.332048	.097731	-.037715	-.032650	-.175148
16	1.231118	-1.530959	0.000000	.070132	.140881	-.173650	-.076948	-.103380	.040703	-.173650	.274053
17	2.386670	-1.530959	0.000000	.095711	.090433	-.173650	-.127488	-.096230	.016555	-.173650	.247741
18	3.542222	-1.530959	0.000000	.190549	.073434	-.314650	-.284295	.058845	.048087	-.032650	-.086820
19	1.415654	-1.998701	0.000000	.206874	.128113	-.173650	-.289825	-.062598	-.027466	-.173650	.151471
20	2.481188	-1.998701	0.000000	.124540	-.002699	-.173650	-.192702	-.096286	-.087695	-.173650	.191176
21	3.546723	-1.998701	0.000000	.206769	-.032055	-.314650	-.319963	.053188	-.061612	-.032650	-.110678
22	1.600170	-2.466397	0.000000	.170030	.055568	-.173650	-.247981	-.174197	-.143171	-.173650	.323006
23	2.575697	-2.466397	0.000000	.154059	.015503	-.173650	-.232395	-.100169	-.082349	-.173650	.203289
24	3.551224	-2.466397	0.000000	.228727	-.071603	-.314650	-.351000	.062395	-.103614	-.032650	-.143375
25	1.784662	-2.934030	0.000000	.192359	.073176	-.173650	-.275693	-.172682	-.137580	-.173650	.324580
26	2.670193	-2.934030	0.000000	.190175	.088538	-.173650	-.271239	-.073527	-.012961	-.173650	.182647
27	3.555723	-2.934030	0.000000	.119597	.018754	-.314650	-.194094	-.012219	-.006614	-.032650	.032195
28	1.969121	-3.401580	0.000000	.141591	.002093	-.173650	-.217201	-.190954	-.189902	-.173650	.315261
29	2.764672	-3.401580	0.000000	.086720	.014855	-.173650	-.126856	-.096168	-.055539	-.173650	.211039
30	3.560222	-3.401580	0.000000	.203868	.100104	-.314650	-.298296	.110529	.082141	-.032650	-.168646

VELOCITIES AND BERNOULLI PRESSURES AT CONTROL POINTS IMMEDIATELY TO RIGHT AND LEFT OF VERTICAL WING SURFACE

J	X(J)	Y(J)	Z(J)	UTOTR	VTOTR	WTOTR	PRESSR	UTOTL	VTOTL	WTOTL	PRESSL
31	1.231118	0.000000	1.530959	-.103380	.173650	-.040703	.274053	.070132	.173650	-.140881	-.076948
32	2.386670	0.000000	1.530959	-.096230	.173650	-.016555	.247741	.095711	.173650	-.090433	-.127488
33	3.542222	0.000000	1.530959	.058845	.314650	-.048087	-.086820	.190549	.032650	-.073434	-.284295
34	1.415654	0.000000	1.998701	-.062598	.173650	.027466	.151471	.206874	.173650	-.128113	-.289825
35	2.481188	0.000000	1.998701	-.096286	.173650	.087695	.191176	.124540	.173650	.002699	-.192702
36	3.546723	0.000000	1.998701	.053188	.314650	.061612	-.110678	.206769	.032650	.032055	-.319963
37	1.600170	0.000000	2.466397	-.174197	.173650	.143171	.323006	.170030	.173650	-.055568	-.247981
38	2.575697	0.000000	2.466397	-.100169	.173650	.082349	.203289	.154059	.173650	-.015503	-.232395
39	3.551224	0.000000	2.466397	.062395	.314650	.103614	-.143375	.228727	.032650	.071603	-.351000
40	1.784662	0.000000	2.934030	-.172682	.173650	.137580	.324580	.192359	.173650	-.073176	-.275693
41	2.670193	0.000000	2.934030	-.073527	.173650	.012961	.182647	.190175	.173650	-.088538	-.271239
42	3.555723	0.000000	2.934030	-.012219	.314650	.006614	.032195	.119597	.032650	-.018754	-.194094
43	1.969121	0.000000	3.401580	-.190954	.173650	.189902	.315261	.141591	.173650	-.002093	-.217201
44	2.764672	0.000000	3.401580	-.096168	.173650	.055539	.211039	.086720	.173650	-.014855	-.126856
45	3.560222	0.000000	3.401580	.110529	.314650	-.082141	-.168646	.203868	.032650	-.100104	-.298296
46	1.231118	0.000000	-1.530959	-.182872	.173650	-.184985	.498202	.146995	.173650	.005464	-.226794
47	2.386670	0.000000	-1.530959	-.116891	.173650	-.167834	.331516	.124947	.173650	-.074735	-.178168
48	3.542222	0.000000	-1.530959	-.071752	.314650	-.200785	.196546	.102488	.032650	-.159554	-.212304
49	1.415654	0.000000	-1.998701	-.107871	.173650	-.074156	.295550	.248685	.173650	.131702	-.374805
50	2.481188	0.000000	-1.998701	-.126751	.173650	-.125204	.352481	.129551	.173650	-.026553	-.193772
51	3.546723	0.000000	-1.998701	-.050582	.314650	-.154275	.149361	.164537	.032650	-.112876	-.246240
52	1.600170	0.000000	-2.466397	-.176806	.173650	-.169078	.482705	.174346	.173650	.033659	-.270827
53	2.575697	0.000000	-2.466397	-.115665	.173650	-.111646	.323032	.165859	.173650	-.003287	-.251365
54	3.551224	0.000000	-2.466397	.042893	.314650	-.130264	-.044916	.239154	.032650	-.092494	-.338894
55	1.784662	0.000000	-2.934030	-.157138	.173650	-.167316	.432284	.178746	.173650	.026607	-.274891
56	2.670193	0.000000	-2.934030	-.083959	.173650	-.057072	.233814	.197168	.173650	.051134	-.303190
57	3.555723	0.000000	-2.934030	-.034274	.314650	-.061348	.099520	.118982	.032650	-.031854	-.190418

Figure 10.- Continued.

58	1.969121	0.000000	-3.401580	-.172306	.173650	-.218409	.467925	.125277	.173650	-.046599	-.183220
59	2.764672	0.000000	-3.401580	-.098299	.173650	-.095385	.277790	.090547	.173650	-.022698	-.131423
60	3.560222	0.000000	-3.401580	.097731	.314650	.037715	-.175148	.212661	.032650	.059834	-.332048

PRESSURE LOADINGS AT CONTROL POINTS

J	X(J)	Y(J)	Z(J)	DELTP.LIN.	DELTP.HERN.
1	1.231118	1.530959	0.000000	.659734	.724996
2	2.386670	1.530959	0.000000	.483756	.509684
3	3.542222	1.530959	0.000000	.428480	.408850
4	1.415654	1.998701	0.000000	.713112	.670355
5	2.481188	1.998701	0.000000	.512603	.546253
6	3.546723	1.998701	0.000000	.430237	.375601
7	1.600170	2.466397	0.000000	.702303	.753532
8	2.575697	2.466397	0.000000	.563049	.574397
9	3.551224	2.466397	0.000000	.392520	.293978
10	1.784662	2.934030	0.000000	.671770	.707175
11	2.670193	2.934030	0.000000	.562255	.537004
12	3.555723	2.934030	0.000000	.306512	.289938
13	1.969121	3.401580	0.000000	.595167	.651145
14	2.764672	3.401580	0.000000	.377692	.409213
15	3.560222	3.401580	0.000000	.229861	.156900
16	1.231118	-1.530959	0.000000	.347024	.351000
17	2.386670	-1.530959	0.000000	.383882	.375229
18	3.542222	-1.530959	0.000000	.263406	.197475
19	1.415654	-1.998701	0.000000	.538940	.441296
20	2.481188	-1.998701	0.000000	.441654	.383878
21	3.546723	-1.998701	0.000000	.307162	.209285
22	1.600170	-2.466397	0.000000	.688454	.570987
23	2.575697	-2.466397	0.000000	.508455	.435683
24	3.551224	-2.466397	0.000000	.332665	.207625
25	1.784662	-2.934030	0.000000	.730082	.600274
26	2.670193	-2.934030	0.000000	.527405	.453886
27	3.555723	-2.934030	0.000000	.263632	.226288
28	1.969121	-3.401580	0.000000	.665088	.532461
29	2.764672	-3.401580	0.000000	.365775	.337895
30	3.560222	-3.401580	0.000000	.186679	.129650
31	1.231118	0.000000	1.530959	.347024	.351000
32	2.386670	0.000000	1.530959	.383882	.375229
33	3.542222	0.000000	1.530959	.263406	.197475
34	1.415654	0.000000	1.998701	.538940	.441296
35	2.481188	0.000000	1.998701	.441654	.383878
36	3.546723	0.000000	1.998701	.307162	.209285
37	1.600170	0.000000	2.466397	.688454	.570987
38	2.575697	0.000000	2.466397	.508455	.435683
39	3.551224	0.000000	2.466397	.332665	.207625
40	1.784662	0.000000	2.934030	.730082	.600274
41	2.670193	0.000000	2.934030	.527405	.453886
42	3.555723	0.000000	2.934030	.263632	.226288
43	1.969121	0.000000	3.401580	.665088	.532461
44	2.764672	0.000000	3.401580	.365775	.337895
45	3.560222	0.000000	3.401580	.186679	.129650
46	1.231118	0.000000	-1.530959	.659734	.724996
47	2.386670	0.000000	-1.530959	.483756	.509684
48	3.542222	0.000000	-1.530959	.428480	.408850
49	1.415654	0.000000	-1.998701	.713112	.670355

Figure 10.- Continued.

50	2.481188	0.000000	-1.998701	.512603	.546253
51	3.546723	0.000000	-1.998701	.430257	.595601
52	1.663170	0.000000	-2.466397	.702503	.753532
53	2.575697	0.000000	-2.466397	.563049	.570397
54	3.551224	0.000000	-2.466397	.392520	.273978
55	1.784662	0.000000	-2.934030	.671770	.707175
56	2.670193	0.000000	-2.934030	.562255	.537004
57	3.555723	0.000000	-2.934030	.306512	.289938
58	1.969121	0.000000	-3.401580	.595167	.651145
59	2.764672	0.000000	-3.401580	.377692	.409213
60	3.560222	0.000000	-3.401580	.229861	.156900

LOADING INFORMATION

MACH NUMBER = .17000E+01
ANGLE OF ATTACK = 10.000 DEGREES
SIDE SLIP ANGLE = 10.000 DEGREES
WING AREA = 13.68666
REFERENCE AREA = 5.30929
REFERENCE LENGTH = 2.69000
EXPOSED WING SPAN H = 4.66000
MOMENT CENTER: XM = 19.50000
ZM = 0.00000

BERNOULLI TYPE LOADING PRESSURE

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
DEFL. ANGLE DEG. =		0.00000	0.00000	0.00000	0.00000	
CTHR =	.49666E-01	.14912E-01	.99211E-02	.99211E-02	.14912E-01	
CZ =	.13535E+01	.66294E+00	.46540E+00	0.	0.	.22517E+00
CY =	-.13535E+01	0.	0.	-.46540E+00	-.66294E+00	-.22517E+00
CM =	-.13488E+01	-.64251E+00	-.45133E+00	0.	0.	-.25492E+00
CLN =	.13488E+01	0.	0.	.45133E+00	.64251E+00	.25492E+00
CLL =	.46320E-13	-.57378E+00	.41884E+00	-.41884E+00	.57378E+00	.13507E-15
FOLLOWING ARE IN WIND-AXIS SYSTEM						
CL =	.18677E+01	.45808E+00	.32145E+00	.32145E+00	.45808E+00	.30869E+00
CY-IND =	.62261E-12	.46877E+00	.32909E+00	-.32909E+00	-.46877E+00	.63505E-12
CDI =	.42193E+00	.10066E+00	.71199E-01	.71199E-01	.10066E+00	.78202E-01
CDI/CL**2 =	.12095E+00					
CM-IND =	-.19074E+01	-.45432E+00	-.31914E+00	-.31914E+00	-.45432E+00	-.36052E+00
CLN-IND =	-.56577E-12	-.29950E+00	-.41222E+00	.41222E+00	.29950E+00	-.56044E-12

NOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW IS SUPERSONIC

Figure 10.- Continued.

********************RIGHT WING********************

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
1	.65426	.20280	0.00000	0.00000	.00352	0.00000	0.00000	0.00000	-.94959	0.00000	.13334
2	.85415	.18342	0.00000	0.00000	.00198	0.00000	0.00000	0.00000	.09066	0.00000	.40340
3	1.05402	.16892	0.00000	0.00000	.00223	0.00000	0.00000	0.00000	.06743	0.00000	.67342
4	1.25386	.14501	0.00000	0.00000	.00198	0.00000	0.00000	0.00000	.11185	0.00000	.94341
5	1.45367	.10335	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.19506	0.00000	1.21335
6	1.55556	0.00000							.48420		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = .72775E-02
SUMFT2 = .27974E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	.00340	.00060	3.64000	1.35100
2	2	.66667	.03845	.00742	3.64000	2.10067
3	3	1.00000	.04624	.01563	3.64000	2.85033

*****T.F. FIN VORTEX INFO******

IVRT	GAMMA/VINF	Y.C.G.
1	.94911	3.15424

Figure 10.- Continued.

******************** LEFT WING ********************

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
7	-.65426	.11396	0.00000	0.00000	-.00097	0.00000	0.00000	0.00000	.53369	0.00000	.13334
8	-.85415	.11759	0.00000	0.00000	.00142	0.00000	0.00000	0.00000	.01743	0.00000	.40340
9	-1.05402	.12647	0.00000	0.00000	-.00085	0.00000	0.00000	0.00000	.04116	0.00000	.67342
10	-1.25386	.12104	0.00000	0.00000	-.00310	0.00000	0.00000	0.00000	-.02535	0.00000	.94341
11	-1.45367	.08490	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.16916	0.00000	1.21335
12	-1.55556	0.00000							-.39778		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = -.29015E-02
SUMFT2 = -.26735E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	-.00396	-.00070	-3.64000	1.35100
2	2	.66667	-.03961	-.00773	-3.64000	2.10067
3	3	1.00000	-.04062	-.01493	-3.64000	2.85033

*****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Y.C.G.
2	.05844	-2.09688
3	-.59187	-3.46609

Figure 10.- Continued.

----------------------UPPER WING----------------------

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSIN	ZBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
13	.65426	.11398	0.00000	0.00000	.00097	0.00000	0.00000	0.00000	-.53369	0.00000	.13334
14	.85415	.11769	0.00000	0.00000	-.00142	0.00000	0.00000	0.00000	-.01743	0.00000	.40340
15	1.05402	.12647	0.00000	0.00000	.00085	0.00000	0.00000	0.00000	-.04116	0.00000	.67342
16	1.25386	.12104	0.00000	0.00000	.00310	0.00000	0.00000	0.00000	.02535	0.00000	.94341
17	1.45367	.08490	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.16916	0.00000	1.21335
18	1.55556	0.00000							.39778		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = .29015E-02
SUMFT2 = .26735E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	4	.33333	.00396	.00070	3.64000	1.35100
2	5	.66667	.03961	.00773	3.64000	2.10067
3	6	1.00000	.04062	.01493	3.64000	2.85033

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Z.C.G.
4	-.05844	2.09688
5	.59187	3.46609

Figure 10.- Continued.

-------------------LOWER WING--------------------

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
19	-.65426	.20280	0.00000	0.00000	-.00352	0.00000	0.00000	0.00000	.94959	0.00000	.13334
20	-.85415	.18342	0.00000	-0.00000	-.00108	0.00000	0.00000	0.00000	-.09046	0.00000	.40340
21	-1.05402	.16892	0.00000	0.00000	-.00223	0.00000	0.00000	0.00000	-.06783	0.00000	.67342
22	-1.25386	.14501	0.00000	0.00000	-.00198	0.00000	0.00000	0.00000	-.11185	0.00000	.94341
23	-1.45367	.10335	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.19506	0.00000	1.21335
24	-1.55556	0.00000							-.48420		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = -.72775E-02
SUMFT2 = -.27974E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	7	.33333	-.00340	-.00060	-3.64000	1.35100
2	8	.66667	-.03845	-.00742	-3.64000	2.10067
3	9	1.00000	-.04624	-.01563	-3.64000	2.85033

*****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Z.C.G.
6	-.94911	-3.15424

Figure 10.- Continued.

AFT OF LEADING EDGE OF FIN ROOTCHORDS

PRESSURE COEFFICIENTS AT POINTS ON BODY MERIDIANS

BODY RING= 1

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.
1	11.25000	20.94000	1.25052	.24874	.10899	.12438	.10735	-.21798	-.20414	0.00000	.58702	.55903
2	33.75000	20.94000	1.06014	.70836	.02510	-.08031	.20926	-.05019	-.17282	0.00000	.65039	.89846
3	56.25000	20.94000	.70836	1.06014	-.03284	-.16979	.05031	.06568	-.04375	0.00000	.91148	1.13287
4	78.75000	20.94000	.24874	1.25052	-.06909	-.03950	-.14496	.13818	.15867	0.00000	1.32099	1.27954
5	101.25000	20.94000	-.24874	1.25052	.05658	.29243	-.17076	-.11315	-.06355	0.00000	.87145	.77109
6	123.75000	20.94000	-.70836	1.06014	.00637	.26577	-.10263	-.01273	.03526	0.00000	1.07133	.97424
7	146.25000	20.94000	-1.06014	.70836	.00637	.10263	-.26577	-.01273	.03526	0.00000	1.07133	.97424
8	168.75000	20.94000	-1.25052	.24874	.05658	.17076	-.29243	-.11315	-.06355	0.00000	.87145	.77109
9	191.25000	20.94000	-1.25052	-.24874	-.06909	.14496	.03950	.13818	.15867	0.00000	1.32099	1.27954
10	213.75000	20.94000	-1.06014	-.70836	-.03284	-.05031	.16979	.06568	-.04375	0.00000	.91148	1.13287
11	236.25000	20.94000	-.70836	-1.06014	.02510	-.20926	.08031	-.05019	-.17282	0.00000	.65039	.89846
12	258.75000	20.94000	-.24874	-1.25052	.10899	-.10735	-.12438	-.21798	-.20414	0.00000	.58702	.55903
13	281.25000	20.94000	.24874	-1.25052	-.12048	.03923	-.21068	.24096	.31248	0.00000	1.63216	1.48746
14	303.75000	20.94000	.70836	-1.06014	-.04817	.15212	-.20247	.09635	.16708	0.00000	1.33800	1.19491
15	326.25000	20.94000	1.06014	-.70836	-.04817	.20247	-.15212	.09635	.16708	0.00000	1.33800	1.19491
16	348.75000	20.94000	1.25052	-.24874	-.12048	.21068	-.03923	.24096	.31248	0.00000	1.63216	1.48746

BODY RING= 2

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.
1	11.25000	22.14000	1.25052	.24874	.10643	.12970	.08047	-.21286	-.18996	0.00000	.61571	.56939
2	33.75000	22.14000	1.06014	.70836	.03484	-.02592	.12779	-.06968	-.12572	0.00000	.74567	.85903
3	56.25000	22.14000	.70836	1.06014	-.04816	-.08119	-.00899	.09632	.06189	0.00000	1.12521	1.19486
4	78.75000	22.14000	.24874	1.25052	-.09199	-.01047	-.15087	.18399	.22506	0.00000	1.45530	1.37220
5	101.25000	22.14000	-.24874	1.25052	.08900	.30860	-.16660	-.17800	-.12513	0.00000	.74687	.63991
6	123.75000	22.14000	-.70836	1.06014	.06068	.27827	-.09511	-.12136	-.07382	0.00000	.85066	.75449
7	146.25000	22.14000	-1.06014	.70836	.06068	.09511	-.27827	-.12136	-.07382	0.00000	.85066	.75449
8	168.75000	22.14000	-1.25052	.24874	.08900	.16660	-.30860	-.17800	-.12513	0.00000	.74687	.63991
9	191.25000	22.14000	-1.25052	-.24874	-.09199	.15087	.01047	.18399	.22506	0.00000	1.45530	1.37220
10	213.75000	22.14000	-1.06014	-.70836	-.04816	.00899	.08119	.09632	.06189	0.00000	1.12521	1.19486
11	236.25000	22.14000	-.70836	-1.06014	.03484	-.12779	.02592	-.06968	-.12572	0.00000	.74567	.85903
12	258.75000	22.14000	-.24874	-1.25052	.10643	-.08047	-.12970	-.21286	-.18996	0.00000	.61571	.56939
13	281.25000	22.14000	.24874	-1.25052	-.13102	.02976	-.21254	.26204	.33398	0.00000	1.67563	1.53010
14	303.75000	22.14000	.70836	-1.06014	-.16212	.15054	-.20351	.32425	.44280	0.00000	1.89578	1.65595
15	326.25000	22.14000	1.06014	-.70836	-.16212	.20351	-.15054	.32425	.44280	0.00000	1.89578	1.65595
16	348.75000	22.14000	1.25052	-.24874	-.13102	.21254	-.02976	.26204	.33398	0.00000	1.67563	1.53010

BODY RING= 3

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.
1	11.25000	23.34000	1.25052	.24874	.09347	.14430	.00695	-.18695	-.14480	0.00000	.70707	.62180
2	33.75000	23.34000	1.06014	.70836	.01523	.01571	.06542	-.03046	-.04966	0.00000	.89954	.93838
3	56.25000	23.34000	.70836	1.06014	-.01296	-.06034	-.02303	.02592	.00788	0.00000	1.01593	1.05244
4	78.75000	23.34000	.24874	1.25052	.00389	-.05293	-.14251	-.00778	.00044	0.00000	1.00090	.98426

Figure 10.- Continued.

5	101,25000	23.34000	-,24874	1,25052	,14838	,34261	-,15880	-,29676	-,22665	0,00000	,54148	,39966
6	123,75000	23.34000	-,70836	1,06014	,13228	,26647	-,10396	-,26457	-,19226	0,00000	,61106	,46478
7	146,25000	23.34000	-1,06014	,70836	,13228	,10396	-,26647	-,26457	-,19226	0,00000	,61106	,46478
8	168,75000	23.34000	-1,25052	,24874	,14838	,15880	-,34261	-,29676	-,22665	0,00000	,54148	,39966
9	191,25000	23.34000	-1,25052	-,24874	,00389	,14251	,05293	-,00778	,00044	0,00000	1,00090	,98426
10	213,75000	23.34000	-1,06014	-,70836	-,01296	,02303	,06034	,02592	,00788	0,00000	1,01593	1,05244
11	236,25000	23.34000	-,70836	-1,06014	,01523	-,06542	-,01571	-,03046	-,04966	0,00000	,69954	,93838
12	258,75000	23.34000	-,24874	-1,25052	,09347	-,00695	-,14430	-,18695	-,14480	0,00000	,70797	,62180
13	281,25000	23.34000	,24874	-1,25052	-,11401	-,04527	-,22745	,22802	,25389	0,00000	1,51362	1,46128
14	303,75000	23.34000	,70836	-1,06014	-,16774	,12646	-,21958	,33549	,45252	0,00000	1,91545	1,67870
15	326,25000	23.34000	1,06014	-,70836	-,16774	,21958	-,12646	,33549	,45252	0,00000	1,91545	1,67870
16	348,75000	23.34000	1,25052	-,24874	-,11401	,22745	,04527	,22802	,25389	0,00000	1,51362	1,46128

Figure 10.- Concluded.

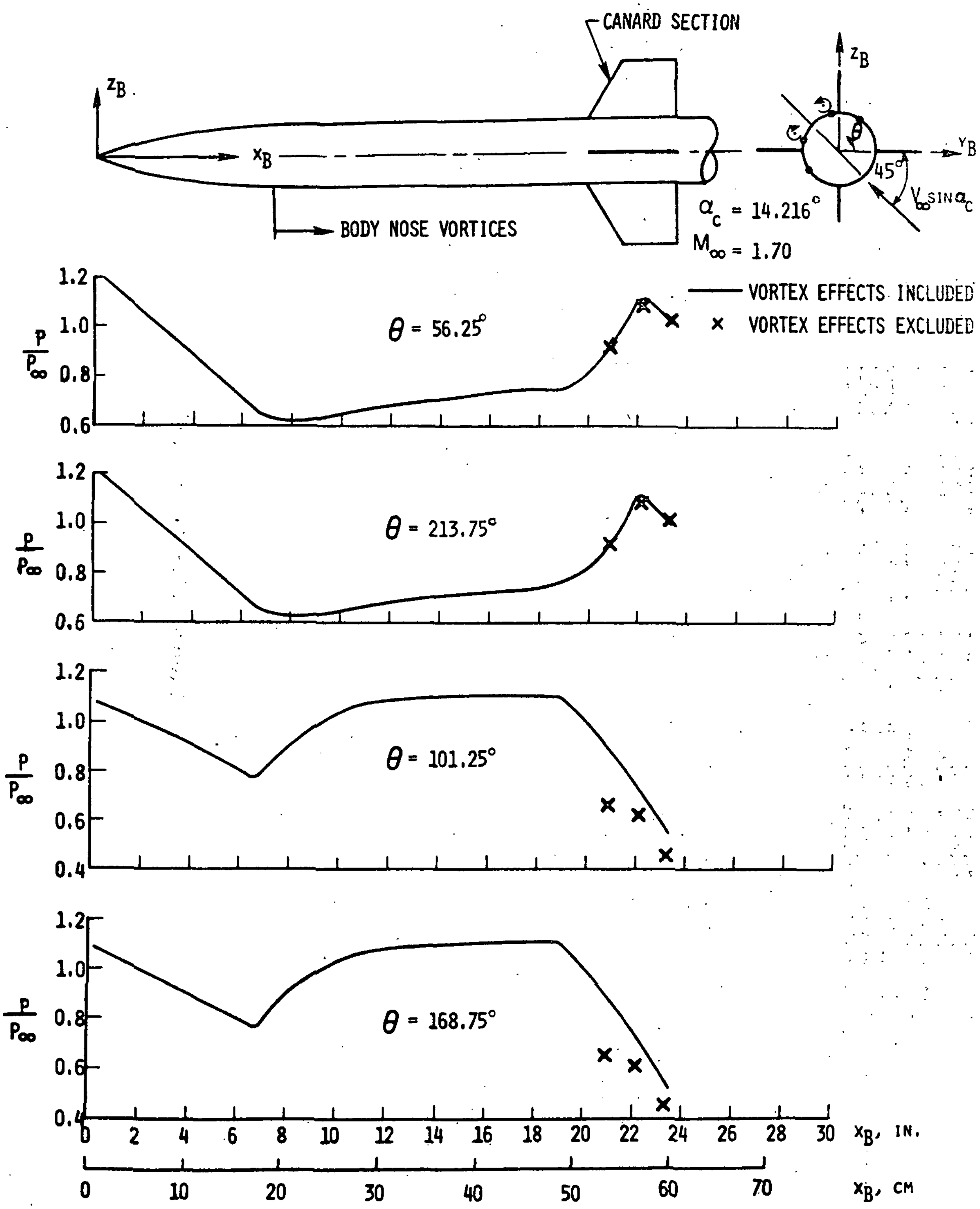


Figure 11(a).- Calculated pressure distributions along body meridians through canard section; first sample case.

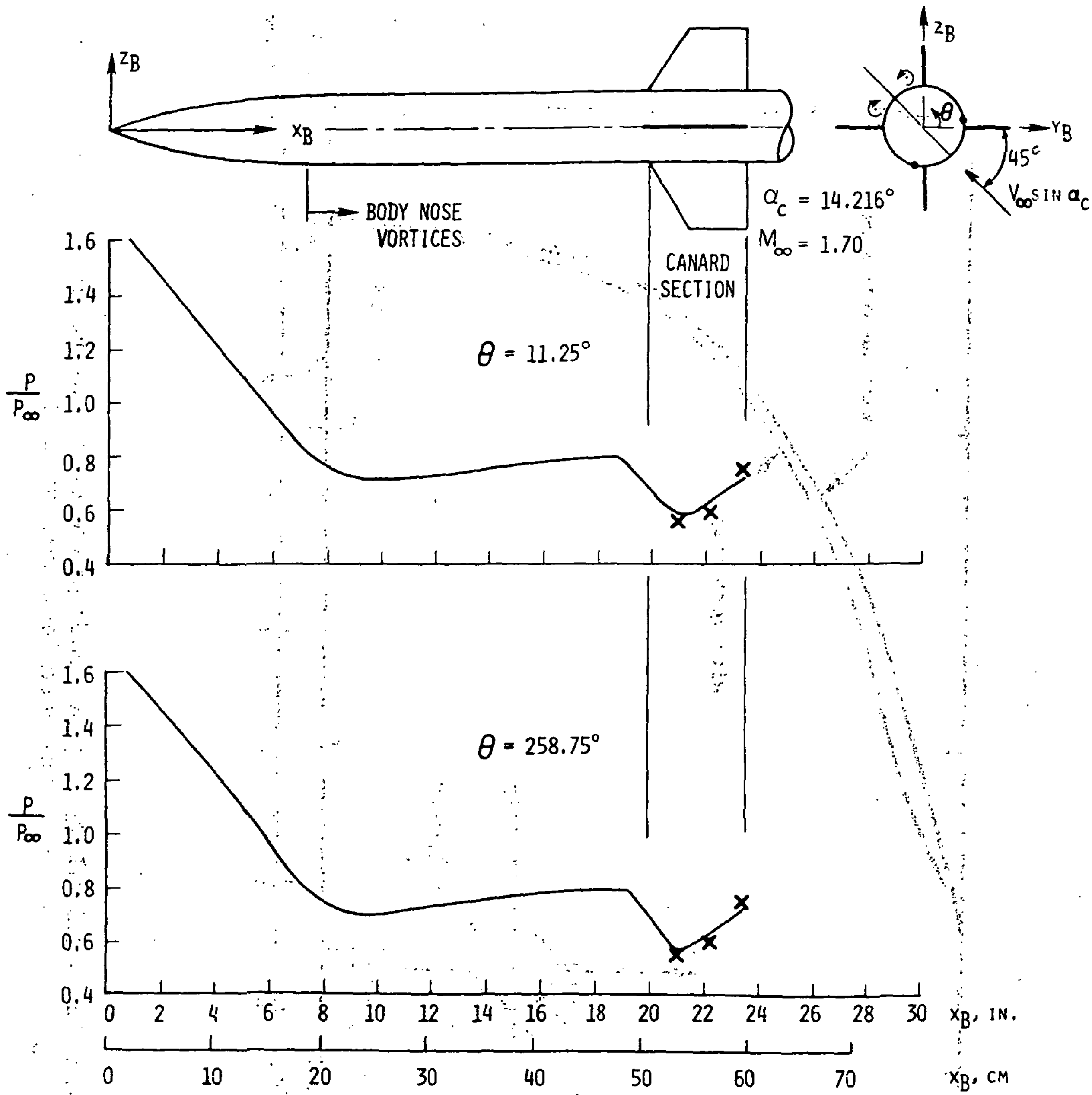


Figure 11(b).- Concluded.

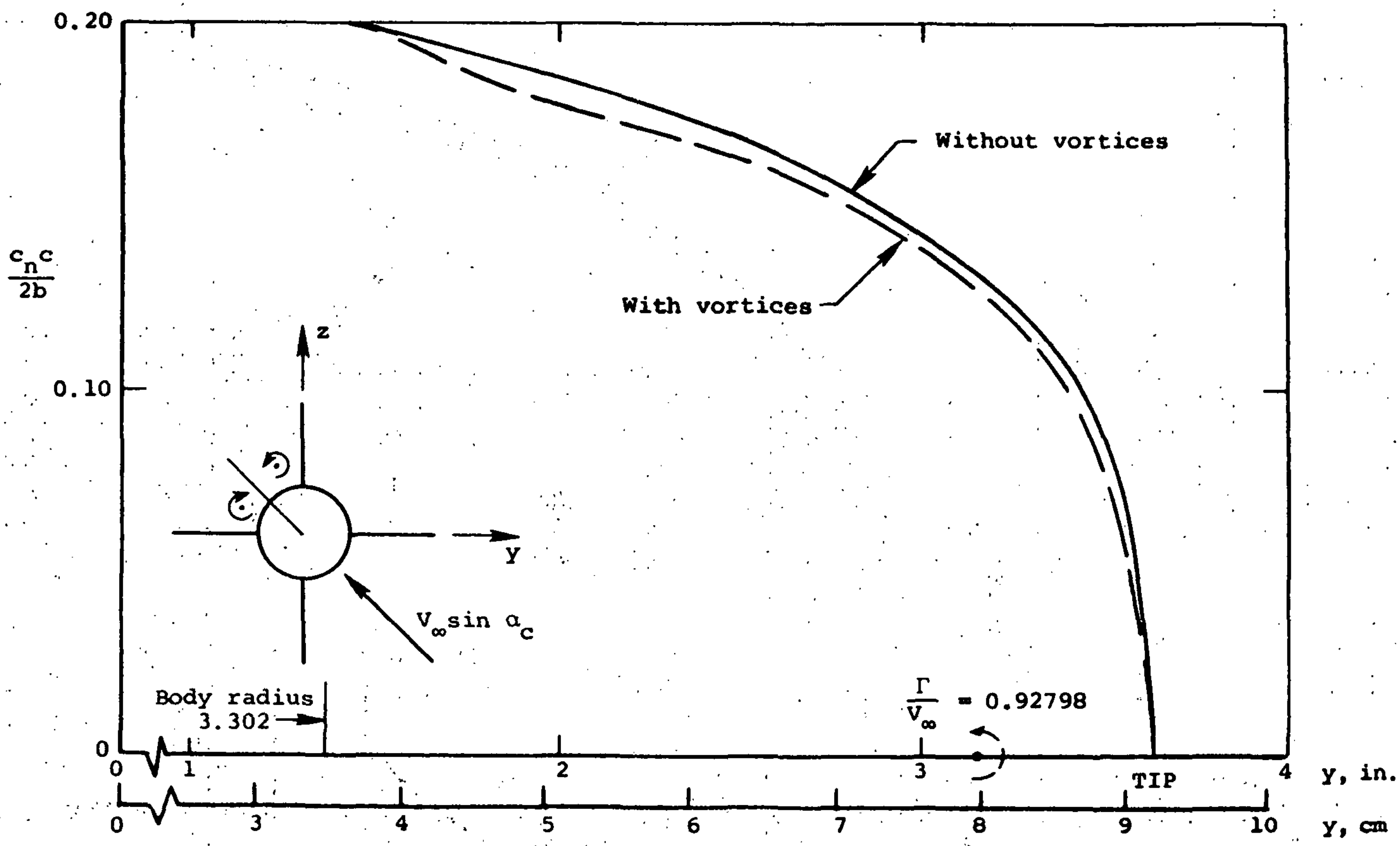


Figure 12.- Calculated span loading on right horizontal canard fin, first sample case, step 3.

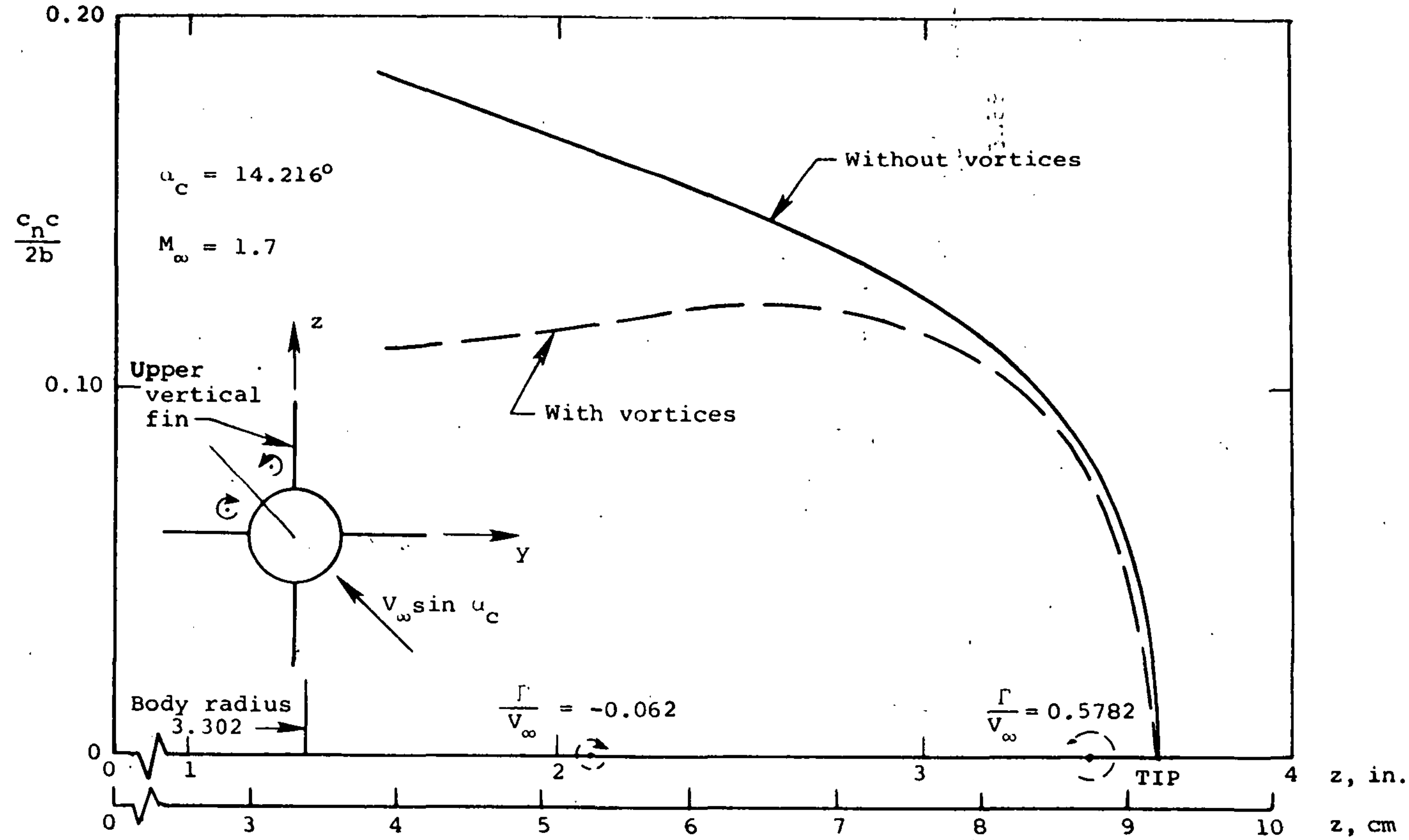


Figure 13.- Calculated span loading on the upper vertical fin, first sample case, step 3.

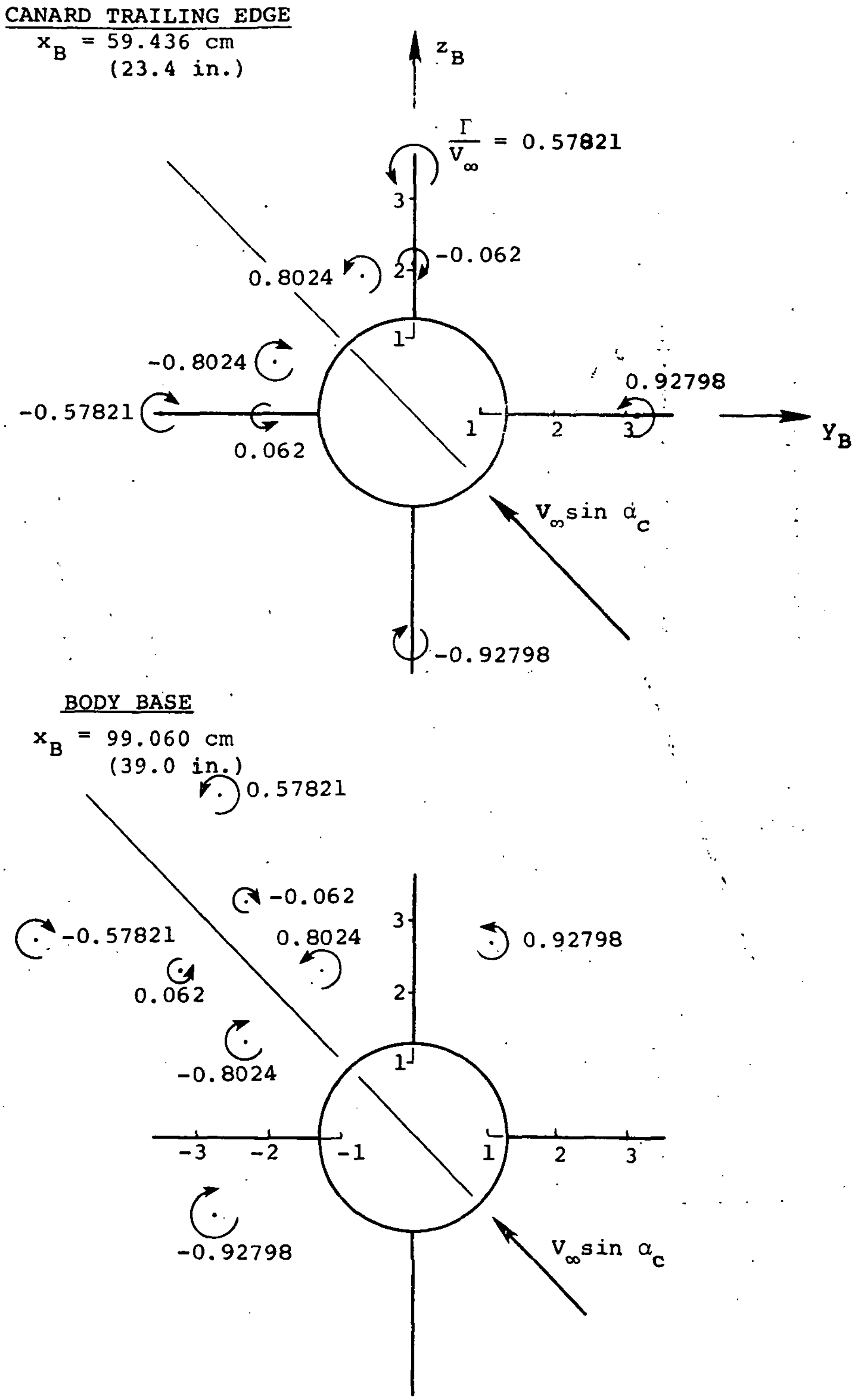


Figure 14.- Calculated vortex positions, first sample case, step 5.

```
NASA/LRC PROJECT 1126,CONFIGURATION B1T4,CHASE VORTICES AFT OF CANARD SECTION.
            1           4           26          1           1           0
 39.0
 1.3
 35.4       1.3         36.751      3.64        39.0        3.64        39.00001    1.3
 14.216     45.0        0.0         0.0         0.0         0.0         0.00001     0.35
   8     8     8     8     8     8     8     8     8     8     8     8     8     8     8     8
   8     8     8     8     8     8     8     8     8     8
-0.68451    1.9192      0.8024      -1.9192     0.68451     -0.8024
3.15424     0.0         0.94911     -2.09688    0.0         0.05844
-3.46609    0.0         -0.59187    0.0         2.09688     -0.05844
0.0         3.46609     0.59187     0.0         -3.15424    -0.94911
 23.4       24.024      24.648      25.272      25.896      26.52       27.144      27.768
 28.392     29.016      29.64       30.264      30.888      31.512      32.136      32.76
 33.384     34.008      34.632      35.256      35.88       36.504      37.128      37.752
 38.376     39.0
            0           0           0           0
            0
```

Figure 15.- Input for program VPATH2, first sample case, step 5.

NASA/LRC PROJECT 1126,CONFIGURATION BIT4,CHASE VORTICES AFT OF CANARD SECTION.

```
                FIN GEOMETRY
        FIN SEMISPAN              =     3.64000
        FIN ROOTCHORD             =     3.60001
        FIN ROOT L.E. X-STATION=       35.40000
                 L.E. Y-STATION=        1.30000
        FIN TIP L.E. X-STATION =       36.75100
                L.E. Y-STATION =        3.64000
        FIN TIP T.E. X-STATION =       39.00000
                T.E. Y-STATION =        3.64000
        FIN ROOT T.E. X-STATION=       39.00001
                 T.E. Y-STATION=        1.30000


   INCLUDED ANGLE OF ATTACK(DEG) =    14.21600     ROLL ANGLE(DEG)   =    45.00000

     PANEL DEFL.(DEG) :

        DELTA1=  0.000    DELTA2=  0.000    DELTA3=  0.000    DELTA4=  0.000


****PERMISSIBLE RELATIVE ERROR,E5,USED IN INTEGRATION SCHEME =    .10000E-04


        VORTEX COORDINATES IN CROSS-FLOW PLANE
        INITIAL VORTEX POSITIONS AT    X = 23.400

   LOCAL BODY RADIUS =     1.30000      LOCAL SEMI SPAN S =    1.30000
```

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.68451E+00	.19192E+01	.80240E+00
2	-.19192E+01	.68451E+00	-.80240E+00
3	.31542E+01	0.	.94911E+00
4	-.20969E+01	0.	.58440E-01
5	-.34661E+01	0.	-.59187E+00
6	0.	.20969E+01	-.58440E-01
7	0.	.34661E+01	.59187E+00
8	0.	-.31542E+01	-.94911E+00

```
   X-STATION NO.  2        X=24.024        INTEGRATION STEP SIZE =     .09984
```

Figure 16.- Output of program VPATH2, first sample case, step 5.

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.70738E+00	.19461E+01	.80240E+00
2	-.19461E+01	.70727E+00	-.80240E+00
3	.30805E+01	.10549E+00	.94911E+00
4	-.22397E+01	.90295E-01	.58440E-01
5	-.35540E+01	.12835E+00	-.59187E+00
6	-.60872E-01	.22397E+01	-.58440E-01
7	-.12871E+00	.35539E+01	.59187E+00
8	-.10505E+00	-.30805E+01	-.94911E+00

X-STATION NO. 3 X=24.646 INTEGRATION STEP SIZE = .19968

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.73263E+00	.19738E+01	.80240E+00
2	-.19739E+01	.73252E+00	-.80240E+00
3	.30063E+01	.21217E+00	.94911E+00
4	-.23810E+01	.17808E+00	.58440E-01
5	-.36395E+01	.25624E+00	-.59187E+00
6	-.17871E+00	.23810E+01	-.58440E-01
7	-.25660E+00	.36394E+01	.59187E+00
8	-.21172E+00	-.30063E+01	-.94911E+00

X-STATION NO. 4 X=25.272 INTEGRATION STEP SIZE = .19968

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.76032E+00	.20019E+01	.80240E+00
2	-.20019E+01	.76021E+00	-.80240E+00
3	.29315E+01	.32003E+00	.94911E+00
4	-.25136E+01	.29043E+00	.58440E-01
5	-.37227E+01	.38294E+00	-.59187E+00
6	-.29112E+00	.25136E+01	-.58440E-01
7	-.38330E+00	.37226E+01	.59187E+00
8	-.31957E+00	-.29315E+01	-.94911E+00

X-STATION NO. 5 X=25.896 INTEGRATION STEP SIZE = .39936

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.79013E+00	.20298E+01	.80240E+00
2	-.20298E+01	.79003E+00	-.80240E+00
3	.28560E+01	.42908E+00	.94911E+00
4	-.26324E+01	.41257E+00	.58440E-01
5	-.38038E+01	.50816E+00	-.59187E+00
6	-.41532E+00	.26324E+01	-.58440E-01
7	-.51852E+00	.38037E+01	.59187E+00
8	-.42861E+00	-.28560E+01	-.94911E+00

X-STATION NO. 6 X=26.520 INTEGRATION STEP SIZE = .39936

Figure 16.- Continued.

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.82163E+00	.20574E+01	.80240E+00
2	-.20574E+01	.82154E+00	-.80240E+00
3	.27796E+01	.53929E+00	.94911E+00
4	-.27354E+01	.53923E+00	.58440E-01
5	-.38629E+01	.65174E+00	-.59187E+00
6	-.54005E+00	.27353E+01	-.58440E-01
7	-.63209E+00	.38828E+01	.59187E+00
8	-.53882E+00	-.27797E+01	-.94911E+00

X-STATION NO. 7 X=27.144 INTEGRATION STEP SIZE = .39936

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.85443E+00	.20845E+01	.80240E+00
2	-.20845E+01	.85435E+00	-.80240E+00
3	.27022E+01	.65064E+00	.94911E+00
4	-.28230E+01	.66517E+00	.58440E-01
5	-.39604E+01	.75356E+00	-.59187E+00
6	-.66704E+00	.28228E+01	-.58440E-01
7	-.75391E+00	.39603E+01	.59187E+00
8	-.65016E+00	-.27023E+01	-.94911E+00

X-STATION NO. 8 X=27.768 INTEGRATION STEP SIZE = .39936

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.88821E+00	.21111E+01	.80240E+00
2	-.21111E+01	.88813E+00	-.80240E+00
3	.26237E+01	.76307E+00	.94911E+00
4	-.28969E+01	.79060E+00	.58440E-01
5	-.40363E+01	.87357E+00	-.59187E+00
6	-.79151E+00	.28966E+01	-.58440E-01
7	-.87392E+00	.40362E+01	.59187E+00
8	-.76258E+00	-.26237E+01	-.94911E+00

X-STATION NO. 9 X=28.392 INTEGRATION STEP SIZE = .39936

Figure 16.- Continued.

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.92271E+00	.21372E+01	.80240E+00
2	-.21372E+01	.92263E+00	-.80240E+00
3	.25437E+01	.87647E+00	.94911E+00
4	-.29594E+01	.91105E+00	.58440E-01
5	-.41110E+01	.99178E+00	-.59187E+00
6	-.91200E+00	.29589E+01	-.58440E-01
7	-.99212E+00	.41109E+01	.59187E+00
8	-.87598E+00	-.25438E+01	-.94911E+00

X-STATION NO. 10 X=29.016 INTEGRATION STEP SIZE = .39936

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.95776E+00	.21628E+01	.80240E+00
2	-.21628E+01	.95769E+00	-.80240E+00
3	.24623E+01	.99075E+00	.94911E+00
4	-.30124E+01	.10269E+01	.58440E-01
5	-.41847E+01	.11082E+01	-.59187E+00
6	-.10279E+01	.30118E+01	-.58440E-01
7	-.11085E+01	.41846E+01	.59187E+00
8	-.99024E+00	-.24624E+01	-.94911E+00

X-STATION NO. 11 X=29.640 INTEGRATION STEP SIZE = .39936

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.99319E+00	.21879E+01	.80240E+00
2	-.21879E+01	.99312E+00	-.80240E+00
3	.23791E+01	.11057E+01	.94911E+00
4	-.30579E+01	.11379E+01	.58440E-01
5	-.42575E+01	.12229E+01	-.59187E+00
6	-.11389E+01	.30572E+01	-.58440E-01
7	-.12232E+01	.42574E+01	.59187E+00
8	-.11052E+01	-.23792E+01	-.94911E+00

X-STATION NO. 12 X=30.264 INTEGRATION STEP SIZE = .79872

Figure 16.- Continued.

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.10289E+01	.22125E+01	.80240E+00
2	-.22125E+01	.10288E+01	-.80240E+00
3	.22942E+01	.12211E+01	.94911E+00
4	-.30974E+01	.12443E+01	.58440E-01
5	-.43297E+01	.13359E+01	-.59187E+00
6	-.12454E+01	.30965E+01	-.58440E-01
7	-.13363E+01	.43295E+01	.59187E+00
8	-.12206E+01	-.22943E+01	-.94911E+00

X-STATION NO. 13 X=30.885 INTEGRATION STEP SIZE = .79872

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.10646E+01	.22363E+01	.80240E+00
2	-.22364E+01	.10646E+01	-.80240E+00
3	.22073E+01	.13368E+01	.94911E+00
4	-.31320E+01	.13463E+01	.58440E-01
5	-.44013E+01	.14474E+01	-.59187E+00
6	-.13473E+01	.31309E+01	-.58440E-01
7	-.14477E+01	.44012E+01	.59187E+00
8	-.13363E+01	-.22074E+01	-.94911E+00

X-STATION NO. 14 X=31.512 INTEGRATION STEP SIZE = .79872

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.11004E+01	.22595E+01	.80240E+00
2	-.22595E+01	.11003E+01	-.80240E+00
3	.21165E+01	.14526E+01	.94911E+00
4	-.31627E+01	.14440E+01	.58440E-01
5	-.44726E+01	.15573E+01	-.59187E+00
6	-.14451E+01	.31615E+01	-.58440E-01
7	-.15576E+01	.44724E+01	.59187E+00
8	-.14521E+01	-.21186E+01	-.94911E+00

X-STATION NO. 15 X=32.136 INTEGRATION STEP SIZE = .79872

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF

Figure 16.- Continued.

1	-.11559E+01	.22817E+01	.80240E+00
2	-.22817E+01	.11559E+01	-.80240E+00
3	.20278E+01	.15681E+01	.94911E+00
4	-.31905E+01	.15379E+01	.58440E-01
5	-.45435E+01	.16657E+01	-.59187E+00
6	-.15389E+01	.31891E+01	-.58440E-01
7	-.16661E+01	.45434E+01	.59187E+00
8	-.15676E+01	-.20279E+01	-.94911E+00

X-STATION NO. 16 X=32.760 INTEGRATION STEP SIZE = .79872

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.11712E+01	.23029E+01	.80240E+00
2	-.23029E+01	.11712E+01	-.80240E+00
3	.19552E+01	.16831E+01	.94911E+00
4	-.32158E+01	.16280E+01	.58440E-01
5	-.46143E+01	.17728E+01	-.59187E+00
6	-.16290E+01	.32142E+01	-.58440E-01
7	-.17732E+01	.46142E+01	.59187E+00
8	-.16826E+01	-.19353E+01	-.94911E+00

X-STATION NO. 17 X=33.384 INTEGRATION STEP SIZE = .79872

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.12060E+01	.23229E+01	.80240E+00
2	-.23229E+01	.12060E+01	-.80240E+00
3	.18409E+01	.17975E+01	.94911E+00
4	-.32392E+01	.17147E+01	.58440E-01
5	-.46850E+01	.18787E+01	-.59187E+00
6	-.17157E+01	.32374E+01	-.58440E-01
7	-.18790E+01	.46848E+01	.59187E+00
8	-.17970E+01	-.18410E+01	-.94911E+00

X-STATION NO. 18 X=34.008 INTEGRATION STEP SIZE = .79872

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.12401E+01	.23415E+01	.80240E+00
2	-.23416E+01	.12401E+01	-.80240E+00
3	.17450E+01	.19111E+01	.94911E+00
4	-.32613E+01	.17982E+01	.58440E-01
5	-.47555E+01	.19833E+01	-.59187E+00
6	-.17992E+01	.32593E+01	-.58440E-01
7	-.19836E+01	.47554E+01	.59187E+00
8	-.19106E+01	-.17452E+01	-.94911E+00

X-STATION NO. 19 X=34.632 INTEGRATION STEP SIZE = .79872

Figure 16.- Continued.

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.12735E+01	.23586E+01	.80240E+00
2	-.23587E+01	.12735E+01	-.80240E+00
3	.16478E+01	.20237E+01	.94911E+00
4	-.32823E+01	.18786E+01	.58440E-01
5	-.48261E+01	.20868E+01	-.59187E+00
6	-.18796E+01	.32802E+01	-.58440E-01
7	-.20871E+01	.48259E+01	.59187E+00
8	-.20232E+01	-.16480E+01	-.94911E+00

X-STATION NO. 20 X=35.256 INTEGRATION STEP SIZE = .79872

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 1.30000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.13058E+01	.23739E+01	.80240E+00
2	-.23740E+01	.13058E+01	-.80240E+00
3	.15495E+01	.21354E+01	.94911E+00
4	-.33028E+01	.19563E+01	.58440E-01
5	-.48966E+01	.21892E+01	-.59187E+00
6	-.19572E+01	.33004E+01	-.58440E-01
7	-.21895E+01	.48964E+01	.59187E+00
8	-.21349E+01	-.15497E+01	-.94911E+00

X-STATION NO. 21 X=35.880 INTEGRATION STEP SIZE = .15600

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 2.13138

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.13363E+01	.23855E+01	.80240E+00
2	-.23856E+01	.13363E+01	-.80240E+00
3	.14500E+01	.22455E+01	.94911E+00
4	-.33221E+01	.20309E+01	.58440E-01
5	-.49667E+01	.22905E+01	-.59187E+00
6	-.20318E+01	.33195E+01	-.58440E-01
7	-.22908E+01	.49665E+01	.59187E+00
8	-.22450E+01	-.14501E+01	-.94911E+00

X-STATION NO. 22 X=36.504 INTEGRATION STEP SIZE = .15600

LOCAL BODY RADIUS = 1.30000 LOCAL SEMI SPAN S = 3.21218

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.13557E+01	.23814E+01	.80240E+00
2	-.23815E+01	.13558E+01	-.80240E+00
3	.13547E+01	.23508E+01	.94911E+00
4	-.33529E+01	.20992E+01	.58440E-01
5	-.50321E+01	.23904E+01	-.59187E+00
6	-.21000E+01	.33301E+01	-.58440E-01
7	-.23907E+01	.50319E+01	.59187E+00
8	-.23503E+01	-.13548E+01	-.94911E+00

Figure 16.- Continued.

X=STATION NO. 23   X=37.128   INTEGRATION STEP SIZE =   .31200

LOCAL BODY RADIUS =   1.30000   LOCAL SEMI SPAN S =   3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.13564E+01	.23648E+01	.80240E+00
2	-.23649E+01	.13564E+01	-.80240E+00
3	.12754E+01	.24485E+01	.94911E+00
4	-.33298E+01	.21551E+01	.58440E-01
5	-.50877E+01	.24880E+01	-.59187E+00
6	-.21558E+01	.33269E+01	-.58440E-01
7	-.24883E+01	.50875E+01	.59187E+00
8	-.24880E+01	-.12756E+01	-.94911E+00

X=STATION NO. 24   X=37.752   INTEGRATION STEP SIZE =   .62400

LOCAL BODY RADIUS =   1.30000   LOCAL SEMI SPAN S =   3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.13546E+01	.23468E+01	.80240E+00
2	-.23469E+01	.13546E+01	-.80240E+00
3	.11981E+01	.25470E+01	.94911E+00
4	-.33275E+01	.22076E+01	.58440E-01
5	-.51432E+01	.25841E+01	-.59187E+00
6	-.22092E+01	.33244E+01	-.58440E-01
7	-.25844E+01	.51430E+01	.59187E+00
8	-.25465E+01	-.11983E+01	-.94911E+00

X=STATION NO. 25   X=38.376   INTEGRATION STEP SIZE =   .62400

LOCAL BODY RADIUS =   1.30000   LOCAL SEMI SPAN S =   3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.13520E+01	.23281E+01	.80240E+00
2	-.23282E+01	.13520E+01	-.80240E+00
3	.11208E+01	.26476E+01	.94911E+00
4	-.33261E+01	.22595E+01	.58440E-01
5	-.51999E+01	.26790E+01	-.59187E+00
6	-.22590E+01	.33246E+01	-.58440E-01
7	-.26793E+01	.51997E+01	.59187E+00
8	-.26471E+01	-.11209E+01	-.94911E+00

X=STATION NO. 26   X=39.000   INTEGRATION STEP SIZE =   .62400

LOCAL BODY RADIUS =   1.30000   LOCAL SEMI SPAN S =   3.64000

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	-.13485E+01	.23086E+01	.80240E+00
2	-.23086E+01	.13486E+01	-.80240E+00
3	.10430E+01	.27506E+01	.94911E+00

Figure 16.- Continued.

4	-.33316E+01	.23082E+01	.58440E-01
5	-.52578E+01	.27729E+01	-.59187E+00
6	-.23086E+01	.33282E+01	-.58440E-01
7	-.27732E+01	.52576E+01	.59187E+00
8	-.27500E+01	-.10432E+01	-.94911E+00

CROSSFLOW VELOCITIES AT CONTROL POINTS INDUCED BY VORTICES AND THEIR IMAGES

IC	X,BODY	Y,BODY	Z,BODY	V	W
1	.36631E+02	.15310E+01	0.	.22541E-01	-.74105E-01
2	.37787E+02	.15310E+01	0.	.19927E-01	-.67006E-01
3	.38942E+02	.15310E+01	0.	.17798E-01	-.61175E-01
4	.36816E+02	.19987E+01	0.	.41619E-01	-.45614E-01
5	.37881E+02	.19987E+01	0.	.37375E-01	-.42293E-01
6	.38947E+02	.19987E+01	0.	.33859E-01	-.39479E-01
7	.37000E+02	.24664E+01	0.	.44308E-01	-.26003E-01
8	.37976E+02	.24664E+01	0.	.40555E-01	-.25016E-01
9	.38951E+02	.24664E+01	0.	.37364E-01	-.24108E-01
10	.37185E+02	.29340E+01	0.	.40999E-01	-.13556E-01
11	.38070E+02	.29340E+01	0.	.38258E-01	-.13699E-01
12	.38956E+02	.29340E+01	0.	.35851E-01	-.13763E-01
13	.37369E+02	.34016E+01	0.	.36017E-01	-.60080E-02
14	.38165E+02	.34016E+01	0.	.34184E-01	-.65582E-02
15	.38960E+02	.34016E+01	0.	.32528E-01	-.70081E-02
16	.36631E+02	-.15310E+01	0.	.25922E-01	-.24335E+00
17	.37787E+02	-.15310E+01	0.	.24109E-01	-.25303E+00
18	.38942E+02	-.15310E+01	0.	.19507E-01	-.25801E+00
19	.36816E+02	-.19987E+01	0.	.51219E-01	-.17161E+00
20	.37881E+02	-.19987E+01	0.	.53408E-01	-.18545E+00
21	.38947E+02	-.19987E+01	0.	.48996E-01	-.19858E+00
22	.37000E+02	-.24664E+01	0.	.59843E-01	-.91572E-01
23	.37976E+02	-.24664E+01	0.	.74149E-01	-.10355E+00
24	.38951E+02	-.24664E+01	0.	.84330E-01	-.12168E+00
25	.37185E+02	-.29340E+01	0.	.56495E-01	-.21821E-01
26	.38070E+02	-.29340E+01	0.	.75910E-01	-.23056E-01
27	.38956E+02	-.29340E+01	0.	.98558E-01	-.29250E-01
28	.37369E+02	-.34016E+01	0.	.43993E-01	.14525E-01
29	.38165E+02	-.34016E+01	0.	.57886E-01	.19927E-01
30	.38960E+02	-.34016E+01	0.	.74961E-01	.25398E-01
31	.36631E+02	.73521E-13	.15310E+01	.24338E+00	-.25911E-01
32	.37787E+02	.73521E-13	.15310E+01	.25305E+00	-.24092E-01
33	.38942E+02	.73521E-13	.15310E+01	.25802E+00	-.19486E-01
34	.36816E+02	.95983E-13	.19987E+01	.17165E+00	-.51210E-01
35	.37881E+02	.95983E-13	.19987E+01	.18549E+00	-.53383E-01
36	.38947E+02	.95983E-13	.19987E+01	.19861E+00	-.48956E-01
37	.37000E+02	.11844E-12	.24664E+01	.91616E-01	-.59862E-01
38	.37976E+02	.11844E-12	.24664E+01	.10560E+00	-.74159E-01
39	.38951E+02	.11844E-12	.24664E+01	.12174E+00	-.84319E-01
40	.37185E+02	.14090E-12	.29340E+01	.21847E-01	-.56537E-01
41	.38070E+02	.14090E-12	.29340E+01	.23094E-01	-.75960E-01
42	.38956E+02	.14090E-12	.29340E+01	.29311E-01	-.98614E-01
43	.37369E+02	.16335E-12	.34016E+01	-.14321E-01	-.44031E-01
44	.38165E+02	.16335E-12	.34016E+01	-.19920E-01	-.57935E-01
45	.38960E+02	.16335E-12	.34016E+01	-.25385E-01	-.75025E-01
46	.36631E+02	-.73521E-13	-.15310E+01	.74107E-01	-.22546E-01
47	.37787E+02	-.73521E-13	-.15310E+01	.67006E-01	-.19931E-01
48	.38942E+02	-.73521E-13	-.15310E+01	.61173E-01	-.17801E-01
49	.36816E+02	-.95983E-13	-.19987E+01	.45611E-01	-.41626E-01
50	.37881E+02	-.95983E-13	-.19987E+01	.42289E-01	-.37381E-01
51	.38947E+02	-.95983E-13	-.19987E+01	.39475E-01	-.33864E-01
52	.37000E+02	-.11844E-12	-.24664E+01	.25997E-01	-.44314E-01
53	.37976E+02	-.11844E-12	-.24664E+01	.25009E-01	-.40561E-01
54	.38951E+02	-.11844E-12	-.24664E+01	.24101E-01	-.37368E-01
55	.37185E+02	-.14090E-12	-.29340E+01	.13548E-01	-.41002E-01

Figure 16.- Continued.

56	.38070E+02	-.14090E-12	-.29340E+01	.13692E-01	-.36261E-01
57	.36956E+02	-.14090E-12	-.29340E+01	.13756E-01	-.35854E-01
58	.37369E+02	-.16335E-12	-.34016E+01	.60006E-02	-.35018E-01
59	.38165E+02	-.16335E-12	-.34016E+01	.65510E-02	-.34185E-01
60	.38960E+02	-.16335E-12	-.34016E+01	.70012E-02	-.32529E-01
61	.36540E+02	.12505E+01	.24874E+00	.21274E-01	-.12873E+00
62	.36540E+02	.10601E+01	.70836E+00	.12767E+00	-.20246E+00
63	.36540E+02	.70836E+00	.10601E+01	.28783E+00	-.19570E+00
64	.36540E+02	.24874E+00	.12505E+01	.32366E+00	-.60836E-01
65	.36540E+02	-.24874E+00	.12505E+01	.24601E+00	.53505E-01
66	.36540E+02	-.70836E+00	.10601E+01	.91774E-01	.73741E-01
67	.36540E+02	-.10601E+01	.70836E+00	-.73710E-01	-.91728E-01
68	.36540E+02	-.12505E+01	.24874E+00	-.53496E-01	-.24796E+00
69	.36540E+02	-.12505E+01	-.24874E+00	.60831E-01	-.32364E+00
70	.36540E+02	-.10601E+01	-.70836E+00	.19573E+00	-.26788E+00
71	.36540E+02	-.70836E+00	-.10601E+01	.20250E+00	-.12770E+00
72	.36540E+02	-.24874E+00	-.12505E+01	.12675E+00	-.21275E-01
73	.36540E+02	.24874E+00	-.12505E+01	.61400E-01	.14560E-01
74	.36540E+02	.70836E+00	-.10601E+01	.14602E-01	.12062E-01
75	.36540E+02	.10601E+01	-.70836E+00	-.12066E-01	-.14607E-01
76	.36540E+02	.12505E+01	-.24874E+00	-.14860E-01	-.61401E-01
77	.37740E+02	.12505E+01	.24874E+00	.19040E-01	-.11463E+00
78	.37740E+02	.10601E+01	.70836E+00	.11255E+00	-.17859E+00
79	.37740E+02	.70836E+00	.10601E+01	.26421E+00	-.18128E+00
80	.37740E+02	.24874E+00	.12505E+01	.32649E+00	-.62557E-01
81	.37740E+02	-.24874E+00	.12505E+01	.25853E+00	.55706E-01
82	.37740E+02	-.70836E+00	.10601E+01	.95893E-01	.77032E-01
83	.37740E+02	-.10601E+01	.70836E+00	-.76997E-01	-.95841E-01
84	.37740E+02	-.12505E+01	.24874E+00	-.55699E-01	-.25849E+00
85	.37740E+02	-.12505E+01	-.24874E+00	.62555E-01	-.32650E+00
86	.37740E+02	-.10601E+01	-.70836E+00	.18130E+00	-.26427E+00
87	.37740E+02	-.70836E+00	-.10601E+01	.17862E+00	-.11257E+00
88	.37740E+02	-.24874E+00	-.12505E+01	.11464E+00	-.19041E-01
89	.37740E+02	.24874E+00	-.12505E+01	.55514E-01	.13401E-01
90	.37740E+02	.70836E+00	-.10601E+01	.13307E-01	.10989E-01
91	.37740E+02	.10601E+01	-.70836E+00	-.10993E-01	-.13314E-01
92	.37740E+02	.12505E+01	-.24874E+00	-.13401E-01	-.55518E-01
93	.38940E+02	.12505E+01	.24874E+00	.17227E-01	-.10318E+00
94	.38940E+02	.10601E+01	.70836E+00	.99922E-01	-.15845E+00
95	.38940E+02	.70836E+00	.10601E+01	.23901E+00	-.16495E+00
96	.38940E+02	.24874E+00	.12505E+01	.31998E+00	-.62611E-01
97	.38940E+02	-.24874E+00	.12505E+01	.26666E+00	.57132E-01
98	.38940E+02	-.70836E+00	.10601E+01	.10026E+00	.80495E-01
99	.38940E+02	-.10601E+01	.70836E+00	-.60458E-01	-.10022E+00
100	.38940E+02	-.12505E+01	.24874E+00	-.57127E-01	-.26062E+00
101	.38940E+02	-.12505E+01	-.24874E+00	.62613E-01	-.32000E+00
102	.38940E+02	-.10601E+01	-.70836E+00	.16499E+00	-.23906E+00
103	.38940E+02	-.70836E+00	-.10601E+01	.15848E+00	-.99937E-01
104	.38940E+02	-.24874E+00	-.12505E+01	.10318E+00	-.17227E-01
105	.38940E+02	.24874E+00	-.12505E+01	.50709E-01	.12211E-01
106	.38940E+02	.70836E+00	-.10601E+01	.12245E-01	.10108E-01
107	.38940E+02	.10601E+01	-.70836E+00	-.10113E-01	-.12252E-01
108	.38940E+02	.12505E+01	-.24874E+00	-.12212E-01	-.50714E-01
109	.25145E+02	.12750E+01	.25362E+00	.51694E-01	-.26088E+00
110	.25145E+02	.12010E+01	.49749E+00	.98361E-01	-.23745E+00
111	.25145E+02	.10809E+01	.72224E+00	.13105E+00	-.19612E+00
112	.25145E+02	.91924E+00	.91924E+00	.15447E+00	-.15447E+00
113	.25145E+02	.72224E+00	.10809E+01	.17758E+00	-.11866E+00
114	.25145E+02	.49749E+00	.12010E+01	.20820E+00	-.86245E-01
115	.25145E+02	.25362E+00	.12750E+01	.25233E+00	-.50196E-01
116	.25145E+02	-.46625E-09	.13000E+01	.31195E+00	.11168E-09
117	.25145E+02	-.25362E+00	.12750E+01	.35000E+00	.72225E-01
118	.25145E+02	-.49749E+00	.12010E+01	.32579E+00	.13497E+00
119	.25145E+02	-.72224E+00	.10809E+01	.17191E+00	.11488E+00
120	.25145E+02	-.91924E+00	.91924E+00	.21260E-04	.19278E-04

Figure 16.- Continued.

121	.25145E+02	-.10809E+01	.72224E+00	-.11485E+00	-.17187E+00
122	.25145E+02	-.12010E+01	.49749E+00	-.13496E+00	-.32577E+00
123	.25145E+02	-.12750E+01	.25362E+00	-.72226E-01	-.35000E+00
124	.25145E+02	-.13000E+01	-.93250E-09	.22377E-09	-.31196E+00
125	.25145E+02	-.12750E+01	-.25362E+00	.50195E-01	-.25232E+00
126	.25145E+02	-.12010E+01	-.49749E+00	.86201E-01	-.20819E+00
127	.25145E+02	-.10809E+01	-.72224E+00	.11865E+00	-.17757E+00
128	.25145E+02	-.91924E+00	-.91924E+00	.15445E+00	-.15445E+00
129	.25145E+02	-.72224E+00	-.10809E+01	.19610E+00	-.13103E+00
130	.25145E+02	-.49749E+00	-.12010E+01	.23743E+00	-.98352E-01
131	.25145E+02	-.25362E+00	-.12750E+01	.26098E+00	-.51893E-01
132	.25145E+02	.13988E-08	-.13000E+01	.24729E+00	.26608E-09
133	.25145E+02	.25362E+00	-.12750E+01	.19580E+00	.38953E-01
134	.25145E+02	.49749E+00	-.12010E+01	.12534E+00	.51932E-01
135	.25145E+02	.72224E+00	-.10809E+01	.56213E-01	.37564E-01
136	.25145E+02	.91924E+00	-.91924E+00	.18354E-04	.17729E-04
137	.25145E+02	.10809E+01	-.72224E+00	-.37535E-01	-.56170E-01
138	.25145E+02	.12010E+01	-.49749E+00	-.51913E-01	-.12530E+00
139	.25145E+02	.12750E+01	-.25362E+00	-.38944E-01	-.19576E+00
140	.25145E+02	.13000E+01	.18659E-08	.35473E-09	-.24726E+00
141	.27197E+02	.12750E+01	.25362E+00	.57843E-01	-.29080E+00
142	.27197E+02	.12010E+01	.49749E+00	.11538E+00	-.27853E+00
143	.27197E+02	.10809E+01	.72224E+00	.15419E+00	-.23075E+00
144	.27197E+02	.91924E+00	.91924E+00	.17505E+00	-.17505E+00
145	.27197E+02	.72224E+00	.10809E+01	.18984E+00	-.12685E+00
146	.27197E+02	.49749E+00	.12010E+01	.20942E+00	-.86749E-01
147	.27197E+02	.25362E+00	.12750E+01	.24021E+00	-.47784E-01
148	.27197E+02	-.46625E-09	.13000E+01	.28172E+00	.10104E-09
149	.27197E+02	-.25362E+00	.12750E+01	.31289E+00	.62238E-01
150	.27197E+02	-.49749E+00	.12010E+01	.27791E+00	.11513E+00
151	.27197E+02	-.72224E+00	.10809E+01	.15109E+00	.10096E+00
152	.27197E+02	-.91924E+00	.91924E+00	.15768E-04	.13993E-04
153	.27197E+02	-.10809E+01	.72224E+00	-.10095E+00	-.15106E+00
154	.27197E+02	-.12010E+01	.49749E+00	-.11512E+00	-.27789E+00
155	.27197E+02	-.12750E+01	.25362E+00	-.62237E-01	-.31289E+00
156	.27197E+02	-.13000E+01	-.93250E-09	.20208E-09	-.28172E+00
157	.27197E+02	-.12750E+01	-.25362E+00	.47781E-01	-.24019E+00
158	.27197E+02	-.12010E+01	-.49749E+00	.66740E-01	-.20940E+00
159	.27197E+02	-.10809E+01	-.72224E+00	.12583E+00	-.18982E+00
160	.27197E+02	-.91924E+00	-.91924E+00	.17503E+00	-.17503E+00
161	.27197E+02	-.72224E+00	-.10809E+01	.23072E+00	-.15416E+00
162	.27197E+02	-.49749E+00	-.12010E+01	.27852E+00	-.11537E+00
163	.27197E+02	-.25362E+00	-.12750E+01	.29082E+00	-.57847E-01
164	.27197E+02	.13988E-08	-.13000E+01	.25424E+00	.27356E-09
165	.27197E+02	.25362E+00	-.12750E+01	.18614E+00	.37032E-01
166	.27197E+02	.49749E+00	-.12010E+01	.11272E+00	.46701E-01
167	.27197E+02	.72224E+00	-.10809E+01	.49035E-01	.32767E-01
168	.27197E+02	.91924E+00	-.91924E+00	.16423E-04	.15983E-04
169	.27197E+02	.10809E+01	-.72224E+00	-.32741E-01	-.48996E-01
170	.27197E+02	.12010E+01	-.49749E+00	-.46681E-01	-.11267E+00
171	.27197E+02	.12750E+01	-.25362E+00	-.37021E-01	-.18608E+00
172	.27197E+02	.13000E+01	.18659E-08	.36467E-09	-.25419E+00
173	.29250E+02	.12750E+01	.25362E+00	.57819E-01	-.29069E+00
174	.29250E+02	.12010E+01	.49749E+00	.12823E+00	-.30958E+00
175	.29250E+02	.10809E+01	.72224E+00	.18263E+00	-.27333E+00
176	.29250E+02	.91924E+00	.91924E+00	.20763E+00	-.20763E+00
177	.29250E+02	.72224E+00	.10809E+01	.21495E+00	-.14362E+00
178	.29250E+02	.49749E+00	.12010E+01	.22129E+00	-.91664E-01
179	.29250E+02	.25362E+00	.12750E+01	.23612E+00	-.46969E-01
180	.29250E+02	-.46625E-09	.13000E+01	.25921E+00	.92966E-10
181	.29250E+02	-.25362E+00	.12750E+01	.27333E+00	.54369E-01
182	.29250E+02	-.49749E+00	.12010E+01	.23805E+00	.98619E-01
183	.29250E+02	-.72224E+00	.10809E+01	.13121E+00	.87680E-01
184	.29250E+02	-.91924E+00	.91924E+00	.12532E-04	.10972E-04
185	.29250E+02	-.10809E+01	.72224E+00	-.67664E-01	-.13119E+00

Figure 16.- Continued.

186	.29250E+02	-.12010E+01	.49749E+00	-.98611E-01	-.23304E+00
187	.29250E+02	-.12750E+01	.25362E+00	-.54566E-01	-.27331E+00
188	.29250E+02	-.13000E+01	-.93250E-09	.18592E-09	-.25919E+00
189	.29250E+02	-.12750E+01	-.25362E+00	.46965E-01	-.23609E+00
190	.29250E+02	-.12010E+01	-.49749E+00	.91548E-01	-.22125E+00
191	.29250E+02	-.10809E+01	-.72224E+00	.14360E+00	-.21491E+00
192	.29250E+02	-.91924E+00	-.91924E+00	.20759E+00	-.20759E+00
193	.29250E+02	-.72224E+00	-.10809E+01	.27551E+00	-.18262E+00
194	.29250E+02	-.49749E+00	-.12010E+01	.30960E+00	-.12824E+00
195	.29250E+02	-.25362E+00	-.12750E+01	.29075E+00	-.57231E-01
196	.29250E+02	.13966E-08	-.13000E+01	.22939E+00	.24683E-09
197	.29250E+02	.25362E+00	-.12750E+01	.15653E+00	.31141E-01
198	.29250E+02	.49749E+00	-.12010E+01	.91194E-01	.37785E-01
199	.29250E+02	.72224E+00	-.10809E+01	.58978E-01	.26047E-01
200	.29250E+02	.91924E+00	-.91924E+00	.11744E-04	.11317E-04
201	.29250E+02	.10809E+01	-.72224E+00	-.26027E-01	-.38949E-01
202	.29250E+02	.12010E+01	-.49749E+00	-.37768E-01	-.91154E-01
203	.29250E+02	.12750E+01	-.25362E+00	-.31130E-01	-.15647E+00
204	.29250E+02	.13000E+01	.18650E-08	.32900E-09	-.22933E+00
205	.31303E+02	.12750E+01	.25362E+00	.49546E-01	-.24911E+00
206	.31303E+02	.12010E+01	.49749E+00	.12370E+00	-.29865E+00
207	.31303E+02	.10809E+01	.72224E+00	.20006E+00	-.29940E+00
208	.31303E+02	.91924E+00	.91924E+00	.24551E+00	-.24551E+00
209	.31303E+02	.72224E+00	.10809E+01	.25475E+00	-.17021E+00
210	.31303E+02	.49749E+00	.12010E+01	.24885E+00	-.10308E+00
211	.31303E+02	.25362E+00	.12750E+01	.24583E+00	-.48900E-01
212	.31303E+02	-.46625E-09	.13000E+01	.24957E+00	.89510E-10
213	.31303E+02	-.25362E+00	.12750E+01	.24707E+00	.49147E-01
214	.31303E+02	-.49749E+00	.12010E+01	.20811E+00	.86214E-01
215	.31303E+02	-.72224E+00	.10809E+01	.11440E+00	.76448E-01
216	.31303E+02	-.91924E+00	.91924E+00	.12027E-04	.10661E-04
217	.31303E+02	-.10809E+01	.72224E+00	-.76431E-01	-.11438E+00
218	.31303E+02	-.12010E+01	.49749E+00	-.66203E-01	-.20809E+00
219	.31303E+02	-.12750E+01	.25362E+00	-.49141E-01	-.24704E+00
220	.31303E+02	-.13000E+01	-.93250E-09	.17899E-09	-.24954E+00
221	.31303E+02	-.12750E+01	-.25362E+00	.48891E-01	-.24579E+00
222	.31303E+02	-.12010E+01	-.49749E+00	.10306E+00	-.24880E+00
223	.31303E+02	-.10809E+01	-.72224E+00	.17019E+00	-.25470E+00
224	.31303E+02	-.91924E+00	-.91924E+00	.24549E+00	-.24549E+00
225	.31303E+02	-.72224E+00	-.10809E+01	.29943E+00	-.20007E+00
226	.31303E+02	-.49749E+00	-.12010E+01	.29872E+00	-.12373E+00
227	.31303E+02	-.25362E+00	-.12750E+01	.24918E+00	-.49560E-01
228	.31303E+02	.13986E-08	-.13000E+01	.18250E+00	.19637E-09
229	.31303E+02	.25362E+00	-.12750E+01	.12022E+00	.23918E-01
230	.31303E+02	.49749E+00	-.12010E+01	.69124E-01	.28640E-01
231	.31303E+02	.72224E+00	-.10809E+01	.29432E-01	.19668E-01
232	.31303E+02	.91924E+00	-.91924E+00	.62402E-05	.59178E-05
233	.31303E+02	.10809E+01	-.72224E+00	-.19657E-01	-.29416E-01
234	.31303E+02	.12010E+01	-.49749E+00	-.28631E-01	-.69101E-01
235	.31303E+02	.12750E+01	-.25362E+00	-.23911E-01	-.12018E+00
236	.31303E+02	.13000E+01	.18650E-08	.26173E-09	-.18244E+00
237	.33355E+02	.12750E+01	.25362E+00	.38101E-01	-.19157E+00
238	.33355E+02	.12010E+01	.49749E+00	.10173E+00	-.24562E+00
239	.33355E+02	.10809E+01	.72224E+00	.18542E+00	-.27750E+00
240	.33355E+02	.91924E+00	.91924E+00	.26061E+00	-.26061E+00
241	.33355E+02	.72224E+00	.10809E+01	.29458E+00	-.19683E+00
242	.33355E+02	.49749E+00	.12010E+01	.28977E+00	-.12003E+00
243	.33355E+02	.25362E+00	.12750E+01	.27176E+00	-.54056E-01
244	.33355E+02	-.46625E-09	.13000E+01	.25552E+00	.91645E-10
245	.33355E+02	-.25362E+00	.12750E+01	.23542E+00	.46831E-01
246	.33355E+02	-.49749E+00	.12010E+01	.18926E+00	.78408E-01
247	.33355E+02	-.72224E+00	.10809E+01	.10231E+00	.68364E-01
248	.33355E+02	-.91924E+00	.91924E+00	.14117E-04	.12898E-04
249	.33355E+02	-.10809E+01	.72224E+00	-.68343E-01	-.10227E+00
250	.33355E+02	-.12010E+01	.49749E+00	-.78393E-01	-.18723E+00

Figure 16.- Continued.

251	.33355E+02	-.12750E+01	.25362E+00	-.46822E-01	-.23538E+00
252	.33355E+02	-.13000E+01	-.93250E-09	.18325E-09	-.25548E+00
253	.33355E+02	-.12750E+01	-.25362E+00	.54046E-01	-.27171E+00
254	.33355E+02	-.12010E+01	-.49749E+00	.12001E+00	-.28973E+00
255	.33355E+02	-.10809E+01	-.72224E+00	.19682E+00	-.29457E+00
256	.33355E+02	-.91924E+00	-.91924E+00	.26064E+00	-.26064E+00
257	.33355E+02	-.72224E+00	-.10809E+01	.27756E+00	-.18546E+00
258	.33355E+02	-.49749E+00	-.12010E+01	.24568E+00	-.10176E+00
259	.33355E+02	-.25362E+00	-.12750E+01	.19162E+00	-.38111E-01
260	.33355E+02	.13946E-08	-.13000E+01	.13693E+00	.14734E-09
261	.33355E+02	.25362E+00	-.12750E+01	.89920E-01	.17890E-01
262	.33355E+02	.49749E+00	-.12010E+01	.51906E-01	.21507E-01
263	.33355E+02	.72224E+00	-.10809E+01	.22193E-01	.14830E-01
264	.33355E+02	.91924E+00	-.91924E+00	.16726E-05	.14291E-05
265	.33355E+02	.10809E+01	-.72224E+00	-.14827E-01	-.22188E-01
266	.33355E+02	.12010E+01	-.49749E+00	-.21503E-01	-.51898E-01
267	.33355E+02	.12750E+01	-.25362E+00	-.17887E-01	-.89904E-01
268	.33355E+02	.13000E+01	.18650E-08	.19641E-09	-.13690E+00

Figure 16.- Concluded.

```
NASA/LANGLEY UPWT PROJ.1126,CONFIGURATION B1T4,
$INPUT
CRP=3.6,SWLEP=30.0,B2=2.34,SWLEV=30.0,CRPV=3.6,B2V=2.34,
NCW=3,MSWR=5,MSWL=5,MSWU=5,MSWD=5,NCRX=1,
ALFAC=14.216,PHI=45.0,FMACH=1.70,
RB=1.3,NBDCR=16,NCWB=3,BIL=3.6,
XWLE=35.4,
XSTART=23.4,
SREF=5.30929,REFL=2.69,
NOLINP=1,NOUT=0,NDRAG=1,NBDYPR=1,NCPOUT=0,NVLIN=1,ITAIL=1,
JCPT=268,
VRTMAX=0.5,
XM=19.5,
NTDAT=1,NCWT=8,
$END
   5     0      0
 0.122      0.0       0.0       0.0       0.0       0.0       0.0      -0.141
 0.122      0.0       0.0       0.0       0.0       0.0       0.0      -0.141
 0.122      0.122     0.0       0.0       0.0       0.0       0.0      -0.141
 0.122      0.122     0.0       0.0       0.0       0.0       0.0      -0.141
 0.122      0.122     0.0       0.0       0.0       0.0      -0.141    -0.141
 0.122      0.0       0.0       0.0       0.0       0.0       0.0      -0.141
$BODY
NXBODY=39,LNOSE=7.8,LBODY=39.0,BCODE=2,
$END
         0         0         0         0
         0
ZZZZZZZZZZ
```

Figure 17.- Input for program DEMON2, first sample case, step 6.

```
NASA/LANGLEY UPWT PROJ.1126,CONFIGURATION B1T4,
$INPUT
CRP      = .36E+01,              SREF     = .530929E+01,
SWLEP    = .3E+02,               REFL     = .269E+01,
SWTEP    = 0.0,                  PHIDIH   = 0.0,
NCW      = 3,                    THETIT   = 0.0,
MSWR     = 5,                    XMLE     = .354E+02,
MSWL     = 5,                    NOLINP   = 1,
ALFAC    = .14216E+02,           NOUT     = 0,
PHI      = .45E+02,              NPR      = 0,
B2       = .234E+01,             NDRAG    = 1,
FMACH    = .17E+01,              NVRTX    = 0,
LVSWP    = 0,                    NPRESS   = 0,
FAC      = .95E+00,              VRTMAX   = .5E+00,
NFVNPR   = 0,                    NCWB     = 3,
TOLFAC   = .1E+01,               NAGAIN   = 0,
MSWU     = 5,                    BIL      = .36E+01,
MSWD     = 5,                    ITAIL    = 1,
SWLEV    = .5E+02,               NVRTPL   = 0,
SWTEV    = 0.0,                  NBDYPR   = 1,
CRPV     = .36E+01,              NTPR     = 0,
B2V      = .234E+01,             NTDAT    = 1,
NCRX     = 1,                    NCWT     = 8,
RR       = .13E+01,              NCPOUT   = 0,
RA       = .13E+01,              NVLIN    = 1,
FRATIO   = .1E+01,               XSTART   = .234E+02,
NBDCR    = 16,                   JCPT     = 268,
DFLR     = 0.0,                  FKLE     = .5E+00,
DFLL     = 0.0,                  FKSE     = .5E+00,
DFLU     = 0.0,                  XM       = .195E+02,
DFLD     = 0.0,                  ZM       = 0.0,
                                 $END
```

Figure 18.- Output of program DEMON2, first sample case, step 6.

WING GEOMETRY

TIP CHORD = 2.24900

ROOT CHORD = 3.60000

WING SEMISPAN = 2.34000

LEADING EDGE SWEEP = 30.00000 DEGREES

TRAILING EDGE SWEEP = 0.00000 DEGREES

FLOW CONDITIONS

MACH = 1.70000 ALPHAC= 14.21600 PHI = 45.00000 ALFA = 10.00010 BETA = 10.00010

CROT = 3.60000
CROTV = 3.60000

WING THICKNESS INPUT DATA

SPANWISE LOCATIONS OF PANEL SIDE EDGES AND SWEEP ANGLES
OF WING SECTION TO THE LEFT

I	SPANWISE LOCATION FEET	LE SWEEP DEGREES	TE SWEEP DEGREES
RIGHT WING SURFACE			
1	1.30000	0.00000	0.00000
2	1.76800	30.00000	0.00000
3	2.23600	30.00000	0.00000
4	2.70400	30.00000	0.00000
5	3.17200	30.00000	0.00000
6	3.64000	30.00000	0.00000

40 THICKNESS PANELS ARE TO BE LAID OUT
5 CHORDWISE ROWS WITH 8 IN EACH ROW

UPPER WING SURFACE

I	SPANWISE LOCATION FEET	LE SWEEP DEGREES	TE SWEEP DEGREES
1	1.30000	0.00000	0.00000
2	1.76800	30.00000	0.00000
3	2.23600	30.00000	0.00000
4	2.70400	30.00000	0.00000
5	3.17200	30.00000	0.00000
6	3.64000	30.00000	0.00000

40 THICKNESS PANELS ARE TO BE LAID OUT
5 CHORDWISE ROWS WITH 8 IN EACH ROW

Figure 18.- Continued.

INPUT VALUES OF THE LOCAL SURFACE SLOPE OF THE THICKNESS
DISTRIBUTION, FOR EACH CHORDWISE ROW THE FIRST VALUE
IS FOR THE PANEL NEAREST THE LEADING EDGE

RIGHT WING SURFACE

ROW	SLOPES							
1	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
2	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
3	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
4	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
5	.12200	.12200	0.00000	0.00000	0.00000	0.00000	-.14100	-.14100

UPPER WING SURFACE

ROW	SLOPES							
1	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
2	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
3	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
4	.12200	.12200	0.00000	0.00000	0.00000	0.00000	0.00000	-.14100
5	.12200	.12200	0.00000	0.00000	0.00000	0.00000	-.14100	-.14100

$BODY

NXBODY = 39.

LNOSE = .78E+01,

LBODY = .39E+02,

BCODE = 2,

$END

PHYSICAL DIMENSIONS OF BODY AND LINE SINGULARITY STRENGTHS REPRESENTING THE BODY AT MACH= 1.7000 ALFAC= 14.2160

	X	R(X)	DR/DX	TX	T(I)	TC(I)
1	0.0000	-.42633E-13	.34286	.58610E-13	.10092	.39463E-01
2	1.0263	.32639	.29353	.57761	-.40121E-01	-.10955E-01
3	2.0526	.60316	.24611	1.2234	-.25012E-01	-.62846E-02
4	3.0789	.83207	.20020	1.9350	-.23274E-01	-.81381E-02
5	4.1053	1.0145	.15547	2.7106	-.18881E-01	-.74517E-02
6	5.1316	1.1515	.11164	3.5485	-.15477E-01	-.75496E-02
7	6.1579	1.2439	.68039E-01	4.4479	-.11952E-01	-.73645E-02
8	7.1842	1.2921	.25613E-01	5.4078	-.83169E-02	-.70718E-02
9	8.2105	1.3000	0.	6.4233	.31078E-01	-.28112E-02
10	9.2368	1.3000	0.	7.4496	.35293E-02	.47755E-02
11	10.2632	1.3000	0.	8.4760	.34046E-02	.39930E-02
12	11.2895	1.3000	0.	9.5023	.14132E-02	.36673E-02
13	12.3158	1.3000	0.	10.529	.93969E-03	.26432E-02
14	13.3421	1.3000	0.	11.555	.55466E-03	.17866E-02
15	14.3684	1.3000	0.	12.581	.36257E-03	.10708E-02
16	15.3947	1.3000	0.	13.608	.23850E-03	.56355E-03
17	16.4211	1.3000	0.	14.634	.16227E-03	.22980E-03
18	17.4474	1.3000	0.	15.660	.11249E-03	.33410E-04

Figure 18.- Continued.

19	18.4737	1.3000	0.	16.686	.74559E-04	-.67235E-04
20	19.5000	1.3000	0.	17.713	.57218E-04	-.10629E-03
21	20.5263	1.3000	0.	18.739	.41794E-04	-.10993E-03
22	21.5526	1.3000	0.	19.765	.30961E-04	-.95708E-04
23	22.5789	1.3000	0.	20.792	.23236E-04	-.75192E-04
24	23.6053	1.3000	0.	21.818	.17650E-04	-.54633E-04
25	24.6316	1.3000	0.	22.844	.13558E-04	-.37078E-04
26	25.6579	1.3000	0.	23.871	.10525E-04	-.23532E-04
27	26.6842	1.3000	0.	24.897	.82509E-05	-.13675E-04
28	27.7105	1.3000	0.	25.923	.65280E-05	-.74713E-05
29	28.7368	1.3000	0.	26.950	.52100E-05	-.35327E-05
30	29.7632	1.3000	0.	27.976	.41922E-05	-.13202E-05
31	30.7895	1.3000	0.	29.002	.33993E-05	-.22844E-06
32	31.8158	1.3000	0.	30.029	.27766E-05	.19378E-06
33	32.8421	1.3000	0.	31.055	.22835E-05	.25675E-06
34	33.8684	1.3000	0.	32.081	.16903E-05	.15784E-06
35	34.8947	1.3000	0.	33.108	.15745E-05	.11691E-07
36	35.9211	1.3000	0.	34.134	.13191E-05	-.12295E-06
37	36.9474	1.3000	0.	35.160	.11112E-05	-.22221E-06
38	37.9737	1.3000	0.	36.186	.94102E-06	-.28188E-06
39	39.0000	1.3000	0.	37.213	0.	0.

POINT COORDINATES AND PERTURBATION VELOCITIES CALCULATED BY PROGRAM VPATH2

IC	XCP	YCP	ZCP	VVEL(IC)	WVEL(IC)
1	36.63100	1.53100	0.00000	.22541E-01	-.74105E-01
2	37.78700	1.53100	0.00000	.19927E-01	-.67006E-01
3	38.94200	1.53100	0.00000	.17798E-01	-.61175E-01
4	36.81600	1.99870	0.00000	.41619E-01	-.45614E-01
5	37.88100	1.99870	0.00000	.37375E-01	-.42293E-01
6	38.94700	1.99870	0.00000	.33959E-01	-.39479E-01
7	37.00000	2.46640	0.00000	.44308E-01	-.26003E-01
8	37.97600	2.46640	0.00000	.40555E-01	-.25016E-01
9	38.95100	2.46640	0.00000	.37364E-01	-.24108E-01
10	37.18500	2.93400	0.00000	.40999E-01	-.13556E-01
11	38.07000	2.93400	0.00000	.38258E-01	-.13699E-01
12	38.95600	2.93400	0.00000	.35851E-01	-.13763E-01
13	37.36900	3.40160	0.00000	.36017E-01	-.60080E-02
14	38.16500	3.40160	0.00000	.34184E-01	-.65582E-02
15	38.96000	3.40160	0.00000	.32528E-01	-.70081E-02
16	36.63100	-1.53100	0.00000	.25922E-01	-.24335E+00
17	37.78700	-1.53100	0.00000	.24109E-01	-.25303E+00
18	38.94200	-1.53100	0.00000	.19507E-01	-.25801E+00
19	36.81600	-1.99870	0.00000	.51219E-01	-.17161E+00
20	37.88100	-1.99870	0.00000	.53408E-01	-.18545E+00
21	38.94700	-1.99870	0.00000	.48996E-01	-.19858E+00
22	37.00000	-2.46640	0.00000	.59843E-01	-.91572E-01
23	37.97600	-2.46640	0.00000	.74149E-01	-.10355E+00
24	38.95100	-2.46640	0.00000	.84330E-01	-.12168E+00
25	37.18500	-2.93400	0.00000	.56495E-01	-.21821E-01
26	38.07000	-2.93400	0.00000	.75910E-01	-.23056E-01
27	38.95600	-2.93400	0.00000	.98558E-01	-.29250E-01
28	37.36900	-3.40160	0.00000	.43943E-01	.14325E-01
29	38.16500	-3.40160	0.00000	.57886E-01	.19927E-01
30	38.96000	-3.40160	0.00000	.74961E-01	.25394E-01
31	36.63100	.00000	1.53100	.24338E+00	-.25911E-01
32	37.78700	.00000	1.53100	.25305E+00	-.24092E-01

Figure 18.- Continued.

33	38.94200	.00000	1.53100	.25802E+00	-.19486E-01
34	36.81600	.00000	1.99870	.17165E+00	-.51210E-01
35	37.88100	.00000	1.99870	.18549E+00	-.53383E-01
36	38.94700	.00000	1.99870	.19861E+00	-.48956E-01
37	37.00000	.00000	2.46640	.91616E-01	-.59462E-01
38	37.97600	.00000	2.46640	.10360E+00	-.74159E-01
39	38.95100	.00000	2.46640	.12174E+00	-.84319E-01
40	37.18500	.00000	2.93400	.21847E-01	-.56537E-01
41	38.07000	.00000	2.93400	.23094E-01	-.75960E-01
42	38.95600	.00000	2.93400	.29311E-01	-.98610E-01
43	37.36900	.00000	3.40160	-.14321E-01	-.44031E-01
44	38.16500	.00000	3.40160	-.19920E-01	-.57935E-01
45	38.96000	.00000	3.40160	-.25385E-01	-.75025E-01
46	36.63100	-.00000	-1.53100	.74107E-01	-.22546E-01
47	37.78700	-.00000	-1.53100	.67006E-01	-.19931E-01
48	38.94200	-.00000	-1.53100	.61173E-01	-.17801E-01
49	36.81600	-.00000	-1.99870	.45611E-01	-.41626E-01
50	37.88100	-.00000	-1.99870	.42289E-01	-.37381E-01
51	38.94700	-.00000	-1.99870	.39475E-01	-.33864E-01
52	37.00000	-.00000	-2.46640	.25997E-01	-.44314E-01
53	37.97600	-.00000	-2.46640	.25009E-01	-.40561E-01
54	38.95100	-.00000	-2.46640	.24101E-01	-.37368E-01
55	37.18500	-.00000	-2.93400	.13548E-01	-.41002E-01
56	38.07000	-.00000	-2.93400	.13692E-01	-.38261E-01
57	38.95600	-.00000	-2.93400	.13756E-01	-.35854E-01
58	37.36900	-.00000	-3.40160	.60006E-02	-.36018E-01
59	38.16500	-.00000	-3.40160	.65510E-02	-.34185E-01
60	38.96000	-.00000	-3.40160	.70012E-02	-.32529E-01
61	36.54000	1.25050	.24874	.21274E-01	-.12873E+00
62	36.54000	1.06010	.70836	.12767E+00	-.20246E+00
63	36.54000	.70836	1.06010	.28783E+00	-.19570E+00
64	36.54000	.24874	1.25050	.32366E+00	-.60836E-01
65	36.54000	-.24874	1.25050	.24801E+00	.53505E-01
66	36.54000	-.70836	1.06010	.91774E-01	.73741E-01
67	36.54000	-1.06010	.70836	-.73710E-01	-.91728E-01
68	36.54000	-1.25050	.24874	-.53496E-01	-.24796E+00
69	36.54000	-1.25050	-.24874	.60831E-01	-.32364E+00
70	36.54000	-1.06010	-.70836	.19573E+00	-.28788E+00
71	36.54000	-.70836	-1.06010	.20250E+00	-.12770E+00
72	36.54000	-.24874	-1.25050	.12875E+00	-.21275E-01
73	36.54000	.24874	-1.25050	.61400E-01	.14860E-01
74	36.54000	.70836	-1.06010	.14602E-01	.12062E-01
75	36.54000	1.06010	-.70836	-.12066E-01	-.14607E-01
76	36.54000	1.25050	-.24874	-.14866E-01	-.61401E-01
77	37.74000	1.25050	.24874	.19040E-01	-.11463E+00
78	37.74000	1.06010	.70836	.11255E+00	-.17859E+00
79	37.74000	.70836	1.06010	.26421E+00	-.18126E+00
80	37.74000	.24874	1.25050	.32649E+00	-.62557E-01
81	37.74000	-.24874	1.25050	.25853E+00	.55706E-01
82	37.74000	-.70836	1.06010	.95893E-01	.77032E-01
83	37.74000	-1.06010	.70836	-.76997E-01	-.95401E-01
84	37.74000	-1.25050	.24874	-.55699E-01	-.25849E+00
85	37.74000	-1.25050	-.24874	.62555E-01	-.32650E+00
86	37.74000	-1.06010	-.70836	.18130E+00	-.26427E+00
87	37.74000	-.70836	-1.06010	.17862E+00	-.11257E+00
88	37.74000	-.24874	-1.25050	.11464E+00	-.19041E-01
89	37.74000	.24874	-1.25050	.55514E-01	.13401E-01
90	37.74000	.70836	-1.06010	.13307E-01	.10989E-01

Figure 18.- Continued.

91	37.74000	1.06010	-.70836	-.10093E+01	-.13314E+01
92	37.74000	1.25050	-.24874	-.13401E-01	-.55518E-01
93	38.94000	1.25050	.24874	.17227E-01	-.10318E+00
94	38.94000	1.06010	.70836	.99922E-01	-.15845E+00
95	38.94000	.70836	1.06010	.23901E+00	-.16495E+00
96	38.94000	.24874	1.25050	.31998E+00	-.82611E-01
97	38.94000	-.24874	1.25050	.26666E+00	.57132E-01
98	38.94000	-.70836	1.06010	.10028E+00	.80495E-01
99	38.94000	-1.06010	.70836	-.80458E-01	-.10022E+00
100	38.94000	-1.25050	.24874	-.57127E-01	-.26662E+00
101	38.94000	-1.25050	-.24874	.62613E-01	-.32000E+00
102	38.94000	-1.06010	-.70836	.16499E+00	-.23906E+00
103	38.94000	-.70836	-1.06010	.15848E+00	-.99937E-01
104	38.94000	-.24874	-1.25050	.10318E+00	-.17227E-01
105	38.94000	.24874	-1.25050	.50709E-01	.12211E-01
106	38.94000	.70836	-1.06010	.12245E-01	.10108E-01
107	38.94000	1.06010	-.70836	-.10113E-01	-.12252E-01
108	38.94000	1.25050	-.24874	-.12712E-01	-.50714E-01
109	25.14500	1.27500	.25362	.51894E-01	-.26088E+00
110	25.14500	1.20100	.49749	.98361E-01	-.23745E+00
111	25.14500	1.08090	.72224	.13105E+00	-.19612E+00
112	25.14500	.91924	.91924	.15447E+00	-.15447E+00
113	25.14500	.72224	1.08090	.17758E+00	-.11865E+00
114	25.14500	.49749	1.20100	.20820E+00	-.86245E-01
115	25.14500	.25362	1.27500	.25233E+00	-.50196E-01
116	25.14500	-.00000	1.30000	.31195E+00	.11188E-09
117	25.14500	-.25362	1.27500	.35000E+00	.72225E-01
118	25.14500	-.49749	1.20100	.32579E+00	.13497E+00
119	25.14500	-.72224	1.08090	.17191E+00	.11488E+00
120	25.14500	-.91924	.91924	.21260E-04	.19278E-04
121	25.14500	-1.08090	.72224	-.11485E+00	-.17187E+00
122	25.14500	-1.20100	.49749	-.13496E+00	-.32577E+00
123	25.14500	-1.27500	.25362	-.72226E-01	-.35000E+00
124	25.14500	-1.30000	-.00000	.22377E-09	-.31196E+00
125	25.14500	-1.27500	-.25362	.50195E-01	-.25232E+00
126	25.14500	-1.20100	-.49749	.86241E-01	-.20819E+00
127	25.14500	-1.08090	-.72224	.11865E+00	-.17757E+00
128	25.14500	-.91924	-.91924	.15445E+00	-.15445E+00
129	25.14500	-.72224	-1.08090	.19610E+00	-.13103E+00
130	25.14500	-.49749	-1.20100	.23743E+00	-.98352E-01
131	25.14500	-.25362	-1.27500	.26088E+00	-.51893E-01
132	25.14500	.00000	-1.30000	.24729E+00	.26608E-09
133	25.14500	.25362	-1.27500	.19580E+00	.38953E-01
134	25.14500	.49749	-1.20100	.12534E+00	.51932E-01
135	25.14500	.72224	-1.08090	.56213E-01	.37564E-01
136	25.14500	.91924	-.91924	.18354E-04	.17729E-04
137	25.14500	1.08090	-.72224	-.37535E-01	-.56170E-01
138	25.14500	1.20100	-.49749	-.51913E-01	-.12530E+00
139	25.14500	1.27500	-.25362	-.38944E-01	-.19576E+00
140	25.14500	1.30000	.00000	.35473E-09	-.24726E+00
141	27.19700	1.27500	.25362	.57843E-01	-.29080E+00
142	27.19700	1.20100	.49749	.11538E+00	-.27853E+00
143	27.19700	1.08090	.72224	.15419E+00	-.23075E+00
144	27.19700	.91924	.91924	.17505E+00	-.17505E+00
145	27.19700	-.72224	1.08090	.18984E+00	-.12685E+00
146	27.19700	-.49749	1.20100	.20942E+00	-.86749E-01
147	27.19700	-.25362	1.27500	.24021E+00	-.47784E-01
148	27.19700	-.00000	1.30000	.28172E+00	.10104E-09

Figure 18.- Continued.

149	27.19700	-.25362	1.27500	.31289E+00	.62238E-01
150	27.19700	-.49749	1.20100	.27791E+00	.11513E+00
151	27.19700	-.72224	1.08090	.15109E+00	.10096E+00
152	27.19700	-.91924	.91924	.15768E-04	.13993E-04
153	27.19700	-1.08090	.72224	-.10095E+00	-.15106E+00
154	27.19700	-1.20100	.49749	-.11512E+00	-.27789E+00
155	27.19700	-1.27500	.25362	-.62237E-01	-.31289E+00
156	27.19700	-1.30000	-.00000	.20208E-09	-.28172E+00
157	27.19700	-1.27500	-.25362	.47781E-01	-.24019E+00
158	27.19700	-1.20100	-.49749	.86740E-01	-.20940E+00
159	27.19700	-1.08090	-.72224	.12683E+00	-.18982E+00
160	27.19700	-.91924	-.91924	.17503E+00	-.17503E+00
161	27.19700	-.72224	-1.08090	.23072E+00	-.15416E+00
162	27.19700	-.49749	-1.20100	.27852E+00	-.11537E+00
163	27.19700	-.25362	-1.27500	.29082E+00	-.57847E-01
164	27.19700	.00000	-1.30000	.25424E+00	.27356E-09
165	27.19700	.25362	-1.27500	.18610E+00	.37032E-01
166	27.19700	.49749	-1.20100	.11272E+00	.46701E-01
167	27.19700	.72224	-1.08090	.49035E-01	.32767E-01
168	27.19700	.91924	-.91924	.16423E-04	.15883E-04
169	27.19700	1.08090	-.72224	-.32741E-01	-.48996E-01
170	27.19700	1.20100	-.49749	-.46681E-01	-.11267E+00
171	27.19700	1.27500	-.25362	-.37021E-01	-.18608E+00
172	27.19700	1.30000	.00000	.36467E-09	-.25419E+00
173	29.25000	1.27500	.25362	.57819E-01	-.29069E+00
174	29.25000	1.20100	.49749	.12823E+00	-.30958E+00
175	29.25000	1.08090	.72224	.18263E+00	-.27333E+00
176	29.25000	.91924	.91924	.20763E+00	-.20763E+00
177	29.25000	.72224	1.08090	.21495E+00	-.14362E+00
178	29.25000	.49749	1.20100	.22124E+00	-.91664E-01
179	29.25000	.25362	1.27500	.23612E+00	-.46969E-01
180	29.25000	-.00000	1.30000	.25921E+00	.92466E-10
181	29.25000	-.25362	1.27500	.27333E+00	.54364E-01
182	29.25000	-.49749	1.20100	.23805E+00	.98619E-01
183	29.25000	-.72224	1.08090	.13121E+00	.87680E-01
184	29.25000	-.91924	.91924	.12532E-04	.10972E-04
185	29.25000	-1.08090	.72224	-.87664E-01	-.13119E+00
186	29.25000	-1.20100	.49749	-.99611E-01	-.23804E+00
187	29.25000	-1.27500	.25362	-.54366E-01	-.27331E+00
188	29.25000	-1.30000	-.00000	.18592E-09	-.25919E+00
189	29.25000	-1.27500	-.25362	.46963E-01	-.23609E+00
190	29.25000	-1.20100	-.49749	.91648E-01	-.22125E+00
191	29.25000	-1.08090	-.72224	.14360E+00	-.21491E+00
192	29.25000	-.91924	-.91924	.20759E+00	-.20759E+00
193	29.25000	-.72224	-1.08090	.27331E+00	-.18262E+00
194	29.25000	-.49749	-1.20100	.30960E+00	-.12824E+00
195	29.25000	-.25362	-1.27500	.29075E+00	-.57831E-01
196	29.25000	.00000	-1.30000	.22939E+00	.24683E-09
197	29.25000	.25362	-1.27500	.15455E+00	.31141E-01
198	29.25000	.49749	-1.20100	.91194E-01	.37785E-01
199	29.25000	.72224	-1.08090	.38978E-01	.26047E-01
200	29.25000	.91924	-.91924	.11744E-04	.11317E-04
201	29.25000	1.08090	-.72224	-.26027E-01	-.38949E-01
202	29.25000	1.20100	-.49749	-.37768E-01	-.91154E-01
203	29.25000	1.27500	-.25362	-.31130E-01	-.15647E+00
204	29.25000	1.30000	.00000	.32900E-09	-.22933E+00
205	31.30300	1.27500	.25362	.49546E-01	-.24911E+00
206	31.30300	1.20100	.49749	.12370E+00	-.29865E+00
207	31.30300	1.08090	.72224	.20006E+00	-.29940E+00

Figure 18.- Continued.

208	31.30300	.91924	.91924	.24551E+00	-.24551E+00
209	31.30300	.72224	1.08090	.25475E+00	-.17021E+00
210	31.30300	.49749	1.20100	.24885E+00	-.10308E+00
211	31.30300	.25362	1.27500	.24583E+00	-.48904E-01
212	31.30300	-.00000	1.30000	.24957E+00	.89510E-10
213	31.30300	-.25362	1.27500	.24707E+00	.49147E-01
214	31.30300	-.49749	1.20100	.20811E+00	.86214E-01
215	31.30300	-.72224	1.08090	.11440E+00	.76448E-01
216	31.30300	-.91924	.91924	.12027E-04	.10661E-04
217	31.30300	-1.08090	.72224	-.76431E-01	-.11438E+00
218	31.30300	-1.20100	.49749	-.66203E-01	-.20808E+00
219	31.30300	-1.27500	.25362	-.49141E-01	-.24704E+00
220	31.30300	-1.30000	-.00000	.17809E-09	-.24954E+00
221	31.30300	-1.27500	-.25362	.48891E-01	-.24579E+00
222	31.30300	-1.20100	-.49749	.10306E+00	-.24880E+00
223	31.30300	-1.08090	-.72224	.17019E+00	-.25470E+00
224	31.30300	-.91924	-.91924	.24549E+00	-.24549E+00
225	31.30300	-.72224	-1.08090	.29943E+00	-.20007E+00
226	31.30300	-.49749	-1.20100	.29872E+00	-.12373E+00
227	31.30300	-.25362	-1.27500	.24918E+00	-.49560E-01
228	31.30300	.00000	-1.30000	.18250E+00	.19637E-09
229	31.30300	.25362	-1.27500	.12022E+00	.23918E-01
230	31.30300	.49749	-1.20100	.69124E-01	.28640E-01
231	31.30300	.72224	-1.08090	.29432E-01	.19668E-01
232	31.30300	.91924	-.91924	.62402E-05	.59178E-05
233	31.30300	1.08090	-.72224	-.19657E-01	-.29416E-01
234	31.30300	1.20100	-.49749	-.28631E-01	-.69101E-01
235	31.30300	1.27500	-.25362	-.23911E-01	-.12018E+00
236	31.30300	1.30000	.00000	.26173E-09	-.18244E+00
237	33.35500	1.27500	.25362	.38101E-01	-.19157E+00
238	33.35500	1.20100	.49749	.10175E+00	-.24562E+00
239	33.35500	1.08090	.72224	.18542E+00	-.27750E+00
240	33.35500	.91924	.91924	.26061E+00	-.26061E+00
241	33.35500	.72224	1.08090	.29458E+00	-.19683E+00
242	33.35500	.49749	1.20100	.28977E+00	-.12003E+00
243	33.35500	.25362	1.27500	.27176E+00	-.54056E-01
244	33.35500	-.00000	1.30000	.25552E+00	.91645E-10
245	33.35500	-.25362	1.27500	.23542E+00	.46831E-01
246	33.35500	-.49749	1.20100	.18926E+00	.78408E-01
247	33.35500	-.72224	1.08090	.10231E+00	.68364E-01
248	33.35500	-.91924	.91924	.14117E-04	.12898E-04
249	33.35500	-1.08090	.72224	-.68343E-01	-.10227E+00
250	33.35500	-1.20100	.49749	-.78393E-01	-.18923E+00
251	33.35500	-1.27500	.25362	-.46822E-01	-.23538E+00
252	33.35500	-1.30000	-.00000	.18325E-09	-.25548E+00
253	33.45500	-1.27500	-.25362	.54006E-01	-.27171E+00
254	33.35500	-1.20100	-.49749	.12001E+00	-.28973E+00
255	33.35500	-1.08090	-.72224	.19642E+00	-.29457E+00
256	33.35500	-.91924	-.91924	.26064E+00	-.26064E+00
257	33.35500	-.72224	-1.08090	.27756E+00	-.18546E+00
258	33.35500	-.49749	-1.20100	.24568E+00	-.10176E+00
259	33.35500	-.25362	-1.27500	.19162E+00	-.38111E-01
260	33.35500	.00000	-1.30000	.13694E+00	.14734E-09
261	33.35500	.25362	-1.27500	.89920E-01	.17890E-01
262	33.35500	.49749	-1.20100	.51906E-01	.21507E-01
263	33.35500	.72224	-1.08090	.22193E-01	.14830E-01
264	33.35500	.91924	-.91924	.16726E-05	.14291E-05
265	33.35500	1.08090	-.72224	-.14827E-01	-.22188E-01

Figure 18.- Continued.

266	33.35500	1.20100	-.49749	-.21503E-01	-.51898E-01
267	33.35500	1.27500	-.25362	-.17887E-01	-.89904E-01
268	33.35500	1.30000	.00000	.19641E-09	-.13690E+00

PRESSURE COEFFICIENTS AT POINTS ON BODY MERIDIANS

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.

TOTAL NUMBER OF PRESSURE POINTS,JCPT= 268

BODY RING= 13

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.
1	11.25000	25.14474	1.27502	.25362	.00178	.14660	-.03041	-.00356	.03653	0.00000	1.07390	.99279
2	22.50000	25.14474	1.20104	.49749	.00176	.09783	.01196	-.00352	.01690	0.00000	1.03419	.99289
3	33.75000	25.14474	1.08091	.72224	.00173	.03527	.03435	-.00347	-.00544	0.00000	.98899	.99299
4	45.00000	25.14474	.91924	.91924	.00171	-.02205	.02205	-.00342	-.01932	0.00000	.96091	.99309
5	56.25000	25.14474	.72224	1.08091	.00168	-.05289	-.02288	-.00337	-.01680	0.00000	.96602	.99319
6	67.50000	25.14474	.49749	1.20104	.00166	-.04121	-.08571	-.00332	.00320	0.00000	1.00647	.99329
7	78.75000	25.14474	.25362	1.27502	.00164	.02186	-.14490	-.00327	.03408	0.00000	1.06894	.99338
8	90.00000	25.14474	-.00000	1.30000	.00162	.13543	-.17544	-.00323	.05799	0.00000	1.11731	.99346
9	101.25000	25.14474	-.25362	1.27502	.00160	.25422	-.15717	-.00320	.05231	0.00000	1.10582	.99353
10	112.50000	25.14474	-.49749	1.20104	.00159	.32525	-.11337	-.00317	.03129	0.00000	1.06331	.99358
11	123.75000	25.14474	-.72224	1.08091	.00158	.26661	-.11451	-.00316	.04659	0.00000	1.09426	.99361
12	135.00000	25.14474	-.91924	.91924	.00158	.17547	-.17543	-.00315	.05965	0.00000	1.12067	.99362
13	146.25000	25.14474	-1.08091	.72224	.00158	.11454	-.26657	-.00316	.04660	0.00000	1.09428	.99361
14	157.50000	25.14474	-1.20104	.49749	.00159	.11339	-.32523	-.00317	.03130	0.00000	1.06332	.99358
15	168.75000	25.14474	-1.27502	.25362	.00160	.15717	-.25422	-.00320	.05231	0.00000	1.10582	.99353
16	180.00000	25.14474	-1.30000	-.00000	.00162	.17544	-.13544	-.00323	.05799	0.00000	1.11731	.99346
17	191.25000	25.14474	-1.27502	-.25362	.00164	.14490	-.02185	-.00327	.03407	0.00000	1.06893	.99338
18	202.50000	25.14474	-1.20104	-.49749	.00166	.08571	.04122	-.00332	.00320	0.00000	1.00646	.99329
19	213.75000	25.14474	-1.08091	-.72224	.00168	.02287	.05290	-.00337	-.01680	0.00000	.96600	.99319
20	225.00000	25.14474	-.91924	-.91924	.00171	-.02207	.02207	-.00342	-.01934	0.00000	.96088	.99309
21	236.25000	25.14474	-.72224	-1.08091	.00173	-.03437	-.03525	-.00347	-.00546	0.00000	.98896	.99299
22	247.50000	25.14474	-.49749	-1.20104	.00176	-.01198	-.09782	-.00352	.01689	0.00000	1.03417	.99289
23	258.75000	25.14474	-.25362	-1.27502	.00178	.03041	-.14660	-.00356	.03653	0.00000	1.07390	.99279
24	270.00000	25.14474	.00000	-1.30000	.00180	.07077	-.17544	-.00360	.04779	0.00000	1.09668	.99271
25	281.25000	25.14474	.25362	-1.27502	.00182	.10002	-.19044	-.00363	.05299	0.00000	1.10720	.99265
26	292.50000	25.14474	.49749	-1.20104	.00183	.12480	-.19641	-.00366	.05598	0.00000	1.11326	.99260
27	303.75000	25.14474	.72224	-1.08091	.00184	.15092	-.19183	-.00367	.05819	0.00000	1.11772	.99257
28	315.00000	25.14474	.91924	-.91924	.00184	.17546	-.17543	-.00368	.05910	0.00000	1.11955	.99256
29	326.25000	25.14474	1.08091	-.72224	.00184	.19186	-.15087	-.00367	.05819	0.00000	1.11771	.99257
30	337.50000	25.14474	1.20104	-.49749	.00183	.19643	-.12476	-.00366	.05598	0.00000	1.11324	.99260
31	348.75000	25.14474	1.27502	-.25362	.00182	.19045	-.09998	-.00363	.05299	0.00000	1.10719	.99265
32	360.00000	25.14474	1.30000	.00000	.00180	.17544	-.07074	-.00360	.04779	0.00000	1.09667	.99271

BODY RING= 14

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.
1	11.25000	27.19737	1.27502	.25362	.00147	.15258	-.06048	-.00293	.04564	0.00000	1.09233	.99406
2	22.50000	27.19737	1.20104	.49749	.00145	.11491	-.02928	-.00290	.03401	0.00000	1.06880	.99414
3	33.75000	27.19737	1.08091	.72224	.00143	.05851	-.00043	-.00286	.01443	0.00000	1.02918	.99422
4	45.00000	27.19737	.91924	.91924	.00141	-.00134	.00134	-.00281	-.00365	0.00000	.99261	.99431

Figure 18.- Continued.

5	56.25000	27.19737	.72224	1.08091	.00138	-.04048	-.03117	-.00277	-.00848	0.00000	.98285	.99440
6	67.50000	27.19737	.49749	1.20104	.00136	-.03983	-.08628	-.00273	.00447	0.00000	1.00904	.99448
7	78.75000	27.19737	.25362	1.27502	.00135	.00989	-.14252	-.00269	.03057	0.00000	1.06183	.99456
8	90.00000	27.19737	-.00000	1.30000	.00133	.10533	-.17544	-.00266	.05513	0.00000	1.11152	.99462
9	101.25000	27.19737	-.25362	1.27502	.00132	.21721	-.16714	-.00263	.05810	0.00000	1.11755	.99468
10	112.50000	27.19737	-.49749	1.20104	.00130	.27744	-.13318	-.00261	.04687	0.00000	1.09483	.99472
11	123.75000	27.19737	-.72224	1.08091	.00130	.24582	-.12841	-.00260	.05241	0.00000	1.10602	.99475
12	135.00000	27.19737	-.91924	.91924	.00130	.17546	-.17543	-.00259	.06024	0.00000	1.12186	.99475
13	146.25000	27.19737	-1.08091	.72224	.00130	.12842	-.24579	-.00260	.05241	0.00000	1.10603	.99475
14	157.50000	27.19737	-1.20104	.49749	.00130	.13319	-.27742	-.00261	.04688	0.00000	1.09484	.99472
15	168.75000	27.19737	-1.27502	.25362	.00132	.16714	-.21721	-.00263	.05810	0.00000	1.11755	.99468
16	180.00000	27.19737	-1.30000	-.00000	.00133	.17544	-.10533	-.00266	.05513	0.00000	1.11152	.99462
17	191.25000	27.19737	-1.27502	-.25362	.00135	.14251	-.00987	-.00269	.03056	0.00000	1.06182	.99456
18	202.50000	27.19737	-1.20104	-.49749	.00136	.08627	.03985	-.00273	.00446	0.00000	1.00902	.99448
19	213.75000	27.19737	-1.08091	-.72224	.00138	.03115	.04050	-.00277	-.00849	0.00000	.98283	.99440
20	225.00000	27.19737	-.91924	-.91924	.00141	-.00136	.00136	-.00281	-.00367	0.00000	.99259	.99431
21	236.25000	27.19737	-.72224	-1.08091	.00143	.00040	-.05848	-.00286	.01441	0.00000	1.02915	.99422
22	247.50000	27.19737	-.49749	-1.20104	.00145	.02927	-.11490	-.00290	.03400	0.00000	1.06879	.99414
23	258.75000	27.19737	-.25362	-1.27502	.00147	.06050	-.15258	-.00293	.04565	0.00000	1.09234	.99406
24	270.00000	27.19737	.00000	-1.30000	.00148	.07785	-.17544	-.00297	.04995	0.00000	1.10106	.99400
25	281.25000	27.19737	.25362	-1.27502	.00150	.09046	-.19234	-.00300	.05198	0.00000	1.10515	.99394
26	292.50000	27.19737	.49749	-1.20104	.00151	.11225	-.20161	-.00302	.05488	0.00000	1.11102	.99390
27	303.75000	27.19737	.72224	-1.08091	.00151	.14377	-.19661	-.00303	.05825	0.00000	1.11784	.99387
28	315.00000	27.19737	.91924	-.91924	.00152	.17546	-.17543	-.00303	.05978	0.00000	1.12093	.99387
29	326.25000	27.19737	1.08091	-.72224	.00151	.19663	-.14373	-.00303	.05825	0.00000	1.11783	.99387
30	337.50000	27.19737	1.20104	-.49749	.00151	.20163	-.11220	-.00302	.05487	0.00000	1.11100	.99390
31	348.75000	27.19737	1.27502	-.25362	.00150	.19235	-.09040	-.00300	.05196	0.00000	1.10512	.99394
32	360.00000	27.19737	1.30000	.00000	.00148	.17544	-.07780	-.00297	.04994	0.00000	1.10104	.99400

BODY RING= 15

1	11.25000	29.25000	1.27502	.25362	.00123	.15258	-.06051	-.00247	.04613	0.00000	1.09332	.99501
2	22.50000	29.25000	1.20104	.49749	.00122	.12782	-.06047	-.00243	.04439	0.00000	1.08981	.99508
3	33.75000	29.25000	1.08091	.72224	.00120	.08704	-.04315	-.00239	.03427	0.00000	1.06933	.99516
4	45.00000	29.25000	.91924	.91924	.00118	.03136	-.03136	-.00235	.01775	0.00000	1.03592	.99524
5	56.25000	29.25000	.72224	1.08091	.00116	-.01523	-.04803	-.00232	.00664	0.00000	1.01343	.99532
6	67.50000	29.25000	.49749	1.20104	.00114	-.02782	-.09125	-.00228	.01080	0.00000	1.02185	.99539
7	78.75000	29.25000	.25362	1.27502	.00112	.00594	-.14173	-.00224	.02960	0.00000	1.05988	.99546
8	90.00000	29.25000	-.00000	1.30000	.00111	.08294	-.17544	-.00221	.05176	0.00000	1.10471	.99552
9	101.25000	29.25000	-.25362	1.27502	.00109	.17774	-.17499	-.00219	.06065	0.00000	1.12270	.99557
10	112.50000	29.25000	-.49749	1.20104	.00108	.23764	-.14967	-.00217	.05564	0.00000	1.11256	.99561
11	123.75000	29.25000	-.72224	1.08091	.00108	.22597	-.14168	-.00216	.05663	0.00000	1.11457	.99563
12	135.00000	29.25000	-.91924	.91924	.00108	.17546	-.17543	-.00215	.06070	0.00000	1.12280	.99564
13	146.25000	29.25000	-1.08091	.72224	.00108	.14169	-.22595	-.00216	.05664	0.00000	1.11457	.99563
14	157.50000	29.25000	-1.20104	.49749	.00108	.14968	-.23763	-.00217	.05564	0.00000	1.11256	.99561
15	168.75000	29.25000	-1.27502	.25362	.00109	.17499	-.17772	-.00219	.06065	0.00000	1.12270	.99557
16	180.00000	29.25000	-1.30000	-.00000	.00111	.17544	-.08292	-.00221	.05175	0.00000	1.10470	.99552
17	191.25000	29.25000	-1.27502	-.25362	.00112	.14172	-.00591	-.00224	.02959	0.00000	1.05986	.99546
18	202.50000	29.25000	-1.20104	-.49749	.00114	.09123	.02786	-.00228	.01078	0.00000	1.02181	.99539
19	213.75000	29.25000	-1.08091	-.72224	.00116	.04801	.01527	-.00232	.00662	0.00000	1.01339	.99532
20	225.00000	29.25000	-.91924	-.91924	.00118	.03132	-.03132	-.00235	.01773	0.00000	1.03587	.99524
21	236.25000	29.25000	-.72224	-1.08091	.00120	.04313	-.08703	-.00239	.03426	0.00000	1.06932	.99516
22	247.50000	29.25000	-.49749	-1.20104	.00122	.06049	-.12783	-.00243	.04440	0.00000	1.08982	.99508
23	258.75000	29.25000	-.25362	-1.27502	.00123	.06057	-.15259	-.00247	.04615	0.00000	1.09336	.99501
24	270.00000	29.25000	.00000	-1.30000	.00125	.05312	-.17544	-.00250	.04473	0.00000	1.09049	.99495
25	281.25000	29.25000	.25362	-1.27502	.00126	.06094	-.19821	-.00252	.04601	0.00000	1.09308	.99490
26	292.50000	29.25000	.49749	-1.20104	.00127	.09078	-.21050	-.00254	.05142	0.00000	1.10403	.99486
27	303.75000	29.25000	.72224	-1.08091	.00128	.13374	-.20331	-.00255	.05761	0.00000	1.11655	.99484

Figure 18.- Continued.

28	315.00000	29.25000	.91924	-.91924	.00128	.17546	-.17543	-.00256	.06028	0.00000	1.12195	.99483
29	326.25000	29.25000	1.08091	-.72224	.00128	.20333	-.13371	-.00255	.05761	0.00000	1.11654	.99484
30	337.50000	29.25000	1.20104	-.49749	.00127	.21052	-.09074	-.00254	.05142	0.00000	1.10401	.99486
31	348.75000	29.25000	1.27502	-.25362	.00126	.19823	-.06088	-.00252	.04599	0.00000	1.09305	.99490
32	360.00000	29.25000	1.30000	.00000	.00125	.17544	-.05306	-.00250	.04472	0.00000	1.09046	.99495

BODY RING= 16

1	11.25000	31.30263	1.27502	.25362	.00105	.14435	-.01905	-.00210	.03433	0.00000	1.06945	.99575
2	22.50000	31.30263	1.20104	.49749	.00103	.12334	-.04966	-.00207	.04159	0.00000	1.08414	.99582
3	33.75000	31.30263	1.08091	.72224	.00102	.10456	-.06934	-.00203	.04401	0.00000	1.08904	.99588
4	45.00000	31.30263	.91924	.91924	.00100	.06935	-.06935	-.00200	.03759	0.00000	1.07604	.99596
5	56.25000	31.30263	.72224	1.08091	.00098	.02469	-.07471	-.00196	.02693	0.00000	1.05448	.99603
6	67.50000	31.30263	.49749	1.20104	.00097	-.00014	-.10272	-.00193	.02360	0.00000	1.04773	.99609
7	78.75000	31.30263	.25362	1.27502	.00095	.01577	-.14368	-.00190	.03342	0.00000	1.06761	.99616
8	90.00000	31.30263	-.00000	1.30000	.00094	.07341	-.17544	-.00187	.05016	0.00000	1.10147	.99621
9	101.25000	31.30263	-.25362	1.27502	.00093	.15157	-.18019	-.00185	.06045	0.00000	1.12230	.99626
10	112.50000	31.30263	-.49749	1.20104	.00092	.20775	-.16205	-.00183	.05964	0.00000	1.12065	.99629
11	123.75000	31.30263	-.72224	1.08091	.00091	.20918	-.15289	-.00182	.05922	0.00000	1.11980	.99631
12	135.00000	31.30263	-.91924	.91924	.00091	.17546	-.17543	-.00182	.06105	0.00000	1.12351	.99632
13	146.25000	31.30263	-1.08091	.72224	.00091	.15291	-.20916	-.00182	.05922	0.00000	1.11980	.99631
14	157.50000	31.30263	-1.20104	.49749	.00092	.16206	-.20772	-.00183	.05964	0.00000	1.12065	.99629
15	168.75000	31.30263	-1.27502	.25362	.00093	.16020	-.15154	-.00185	.06045	0.00000	1.12229	.99626
16	180.00000	31.30263	-1.30000	-.00000	.00094	.17544	-.07338	-.00187	.05015	0.00000	1.10146	.99621
17	191.25000	31.30263	-1.27502	-.25362	.00095	.14368	-.01573	-.00190	.03341	0.00000	1.06758	.99616
18	202.50000	31.30263	-1.20104	-.49749	.00097	.10270	.00019	-.00193	.02357	0.00000	1.04769	.99609
19	213.75000	31.30263	-1.08091	-.72224	.00098	.07469	-.02464	-.00196	.02691	0.00000	1.05444	.99603
20	225.00000	31.30263	-.91924	-.91924	.00100	.06933	-.06933	-.00200	.03758	0.00000	1.07603	.99596
21	236.25000	31.30263	-.72224	-1.08091	.00102	.06937	-.10457	-.00203	.04402	0.00000	1.08906	.99588
22	247.50000	31.30263	-.49749	-1.20104	.00103	.04973	-.12337	-.00207	.04161	0.00000	1.08419	.99582
23	258.75000	31.30263	-.25362	-1.27502	.00105	.01912	-.14434	-.00210	.03436	0.00000	1.06950	.99575
24	270.00000	31.30263	.00000	-1.30000	.00106	.00634	-.17544	-.00213	.03092	0.00000	1.06254	.99570
25	281.25000	31.30263	.25362	-1.27502	.00107	.02472	-.20542	-.00215	.03593	0.00000	1.07269	.99566
26	292.50000	31.30263	.49749	-1.20104	.00108	.06876	-.21963	-.00216	.04658	0.00000	1.09424	.99562
27	303.75000	31.30263	.72224	-1.08091	.00109	.12422	-.20967	-.00217	.05663	0.00000	1.11457	.99560
28	315.00000	31.30263	.91924	-.91924	.00109	.17545	-.17544	-.00218	.06068	0.00000	1.12275	.99559
29	326.25000	31.30263	1.08091	-.72224	.00109	.20968	-.12420	-.00217	.05663	0.00000	1.11457	.99560
30	337.50000	31.30263	1.20104	-.49749	.00108	.21963	-.06874	-.00216	.04658	0.00000	1.09423	.99562
31	348.75000	31.30263	1.27502	-.25362	.00107	.20543	-.02468	-.00215	.03592	0.00000	1.07266	.99566
32	360.00000	31.30263	1.30000	.00000	.00106	.17544	-.00628	-.00213	.03090	0.00000	1.06250	.99570

BODY RING= 17

1	11.25000	33.35526	1.27502	.25362	.00090	.13291	.03838	-.00180	.01205	0.00000	1.02437	.99635
2	22.50000	33.35526	1.20104	.49749	.00089	.10142	.00325	-.00178	.02243	0.00000	1.04537	.99641
3	33.75000	33.35526	1.08091	.72224	.00087	.08999	-.04755	-.00175	.03664	0.00000	1.07413	.99646
4	45.00000	33.35526	.91924	.91924	.00086	.08454	-.08454	-.00172	.04410	0.00000	1.08921	.99652
5	56.25000	33.35526	.72224	1.08091	.00084	.06463	-.10140	-.00169	.04283	0.00000	1.08664	.99658
6	67.50000	33.35526	.49749	1.20104	.00083	.04090	-.11972	-.00166	.03923	0.00000	1.07936	.99664
7	78.75000	33.35526	.25362	1.27502	.00082	.04181	-.14886	-.00163	.04194	0.00000	1.08484	.99670
8	90.00000	33.35526	-.00000	1.30000	.00081	.07945	-.17544	-.00161	.05169	0.00000	1.10457	.99674
9	101.25000	33.35526	-.25362	1.27502	.00080	.13999	-.18249	-.00159	.05999	0.00000	1.12135	.99678
10	112.50000	33.35526	-.49749	1.20104	.00079	.18895	-.16984	-.00158	.06105	0.00000	1.12350	.99681
11	123.75000	33.35526	-.72224	1.08091	.00078	.19712	-.16096	-.00157	.06055	0.00000	1.12250	.99683
12	135.00000	33.35526	-.91924	.91924	.00078	.17546	-.17543	-.00157	.06132	0.00000	1.12406	.99683
13	146.25000	33.35526	-1.08091	.72224	.00078	.16098	-.19708	-.00157	.06056	0.00000	1.12251	.99683
14	157.50000	33.35526	-1.20104	.49749	.00079	.16985	-.18892	-.00158	.06105	0.00000	1.12350	.99681

Figure 18.- Continued.

15	168.75000	33.35526	-1.27502	.25362	.00080	.18250	-.13995	-.00159	.05998	0.00000	1.12135	.99678
16	180.00000	33.35526	-1.30000	-.00000	.00081	.17544	-.07941	-.00161	.05168	0.00000	1.10456	.99674
17	191.25000	33.35526	-1.27502	-.25362	.00082	.14885	-.04176	-.00163	.04193	0.00000	1.08481	.99670
18	202.50000	33.35526	-1.20104	-.49749	.00083	.11970	-.00086	-.00166	.03922	0.00000	1.07934	.99664
19	213.75000	33.35526	-1.08091	-.72224	.00084	.10139	-.06462	-.00169	.04282	0.00000	1.08663	.99658
20	225.00000	33.35526	-.91924	-.91924	.00086	.08457	-.08457	-.00172	.04411	0.00000	1.08923	.99652
21	236.25000	33.35526	-.72224	-1.08091	.00087	.04761	-.09003	-.00175	.03667	0.00000	1.07417	.99646
22	247.50000	33.35526	-.49749	-1.20104	.00089	-.00319	-.10145	-.00178	.02245	0.00000	1.04542	.99641
23	258.75000	33.35526	-.25362	-1.27502	.00090	-.03833	-.13292	-.00180	.01207	0.00000	1.02441	.99635
24	270.00000	33.35526	.00000	-1.30000	.00091	-.03914	-.17544	-.00183	.01338	0.00000	1.02707	.99631
25	281.25000	33.35526	.25362	-1.27502	.00092	-.00551	-.21144	-.00185	.02545	0.00000	1.05148	.99627
26	292.50000	33.35526	.49749	-1.20104	.00093	.05159	-.22674	-.00186	.04200	0.00000	1.08498	.99624
27	303.75000	33.35526	.72224	-1.08091	.00093	.11700	-.21450	-.00187	.05573	0.00000	1.11274	.99622
28	315.00000	33.35526	.91924	-.91924	.00094	.17545	-.17544	-.00187	.06100	0.00000	1.12340	.99621
29	326.25000	33.35526	1.08091	-.72224	.00093	.21450	-.11699	-.00187	.05573	0.00000	1.11274	.99622
30	337.50000	33.35526	1.20104	-.49749	.00093	.22674	-.05158	-.00186	.04200	0.00000	1.08497	.99624
31	348.75000	33.35526	1.27502	-.25362	.00092	.21144	.00553	-.00185	.02544	0.00000	1.05146	.99627
32	360.00000	33.35526	1.30000	.00000	.00091	.17544	.03917	-.00183	.01337	0.00000	1.02704	.99631

TOTAL NUMBER OF PRESSURE POINTS,JCPT= 268

CONTROL POINT COORDINATES FOR 3 CHORDWISE BY 5 SPANWISE PANELS ON WING 1 OR R, 5 SPANWISE ON WING 2 OR L
AND 5 SPANWISE PANELS ON WING 3 OR U, 5 SPANWISE ON WING 4 OR D

J	X(J)	Y(J)	Z(J)	BU(J)	BV(J)	BW(J)	VVRTX	WVRTX
1	1.23112	1.53096	0.00000	.73049E-03	.12641E+00	.12694E+00	0.	0.
2	2.38667	1.53096	0.00000	.67838E-03	.12642E+00	.12691E+00	0.	0.
3	3.54222	1.53096	0.00000	.63160E-03	.12643E+00	.12689E+00	0.	0.
4	1.41565	1.99870	0.00000	.72683E-03	.74025E-01	.74581E-01	0.	0.
5	2.48119	1.99870	0.00000	.67887E-03	.74039E-01	.74559E-01	0.	0.
6	3.54672	1.99870	0.00000	.63539E-03	.74051E-01	.74538E-01	0.	0.
7	1.60017	2.46640	0.00000	.72543E-03	.48483E-01	.49061E-01	0.	0.
8	2.57570	2.46640	0.00000	.68143E-03	.48500E-01	.49043E-01	0.	0.
9	3.55122	2.46640	0.00000	.64127E-03	.48516E-01	.49027E-01	0.	0.
10	1.78466	2.93403	0.00000	.72621E-03	.34141E-01	.34740E-01	0.	0.
11	2.67019	2.93403	0.00000	.68608E-03	.34160E-01	.34725E-01	0.	0.
12	3.55572	2.93403	0.00000	.64898E-03	.34177E-01	.34711E-01	0.	0.
13	1.96912	3.40158	0.00000	.72815E-03	.25290E-01	.25908E-01	0.	0.
14	2.76467	3.40158	0.00000	.69164E-03	.25309E-01	.25895E-01	0.	0.
15	3.56022	3.40158	0.00000	.65783E-03	.25326E-01	.25883E-01	0.	0.
16	1.23112	-1.53096	0.00000	.64864E-03	.12645E+00	.12694E+00	0.	0.
17	2.38667	-1.53096	0.00000	.60465E-03	.12645E+00	.12691E+00	0.	0.
18	3.54222	-1.53096	0.00000	.56508E-03	.12645E+00	.12689E+00	0.	0.
19	1.41565	-1.99870	0.00000	.63974E-03	.74120E-01	.74581E-01	0.	0.
20	2.48119	-1.99870	0.00000	.59980E-03	.74125E-01	.74559E-01	0.	0.
21	3.54672	-1.99870	0.00000	.56342E-03	.74129E-01	.74538E-01	0.	0.
22	1.60017	-2.46640	0.00000	.63001E-03	.48627E-01	.49061E-01	0.	0.
23	2.57570	-2.46640	0.00000	.59399E-03	.48631E-01	.49043E-01	0.	0.
24	3.55122	-2.46640	0.00000	.56103E-03	.48636E-01	.49027E-01	0.	0.
25	1.78466	-2.93403	0.00000	.62103E-03	.34329E-01	.34740E-01	0.	0.
26	2.67019	-2.93403	0.00000	.58890E-03	.34333E-01	.34725E-01	0.	0.
27	3.55572	-2.93403	0.00000	.55908E-03	.34336E-01	.34711E-01	0.	0.
28	1.96912	-3.40158	0.00000	.61243E-03	.25519E-01	.25908E-01	0.	0.
29	2.76467	-3.40158	0.00000	.58375E-03	.25521E-01	.25895E-01	0.	0.
30	3.56022	-3.40158	0.00000	.55720E-03	.25523E-01	.25883E-01	0.	0.

Figure 18.- Continued.

31	1.23112	0.00000	1.53096	.64864E-03	-.12694E+00	-.12645E+00	0.	0.
32	2.38667	0.00000	1.53096	.60465E-03	-.12691E+00	-.12645E+00	0.	0.
33	3.54222	0.00000	1.53096	.56568E-03	-.12689E+00	-.12645E+00	0.	0.
34	1.41565	0.00000	1.99870	.63974E-03	-.74581E-01	-.74120E-01	0.	0.
35	2.48119	0.00000	1.99870	.59960E-03	-.74559E-01	-.74125E-01	0.	0.
36	3.54672	0.00000	1.99870	.56302E-03	-.74538E-01	-.74129E-01	0.	0.
37	1.60017	0.00000	2.46640	.63001E-03	-.49061E-01	-.48627E-01	0.	0.
38	2.57570	0.00000	2.46640	.59309E-03	-.49043E-01	-.48631E-01	0.	0.
39	3.55122	0.00000	2.46640	.56103E-03	-.49027E-01	-.48636E-01	0.	0.
40	1.78466	0.00000	2.93403	.62103E-03	-.34740E-01	-.34329E-01	0.	0.
41	2.67019	0.00000	2.93403	.58890E-03	-.34725E-01	-.34333E-01	0.	0.
42	3.55572	0.00000	2.93403	.55908E-03	-.34711E-01	-.34336E-01	0.	0.
43	1.96912	0.00000	3.40158	.61235E-03	-.25908E-01	-.25519E-01	0.	0.
44	2.76467	0.00000	3.40158	.58375E-03	-.25895E-01	-.25521E-01	0.	0.
45	3.56022	0.00000	3.40158	.55720E-03	-.25883E-01	-.25523E-01	0.	0.
46	1.23112	0.00000	-1.53096	.73049E-03	-.12694E+00	-.12641E+00	0.	0.
47	2.38667	0.00000	-1.53096	.67838E-03	-.12691E+00	-.12642E+00	0.	0.
48	3.54222	0.00000	-1.53096	.63160E-03	-.12689E+00	-.12643E+00	0.	0.
49	1.41565	0.00000	-1.99870	.72684E-03	-.74581E-01	-.74025E-01	0.	0.
50	2.48119	0.00000	-1.99870	.67887E-03	-.74559E-01	-.74039E-01	0.	0.
51	3.54672	0.00000	-1.99870	.63559E-03	-.74538E-01	-.74051E-01	0.	0.
52	1.60017	0.00000	-2.46640	.72543E-03	-.49061E-01	-.48483E-01	0.	0.
53	2.57570	0.00000	-2.46640	.68143E-03	-.49043E-01	-.48506E-01	0.	0.
54	3.55122	0.00000	-2.46640	.64127E-03	-.49027E-01	-.48516E-01	0.	0.
55	1.78466	0.00000	-2.93403	.72621E-03	-.34740E-01	-.34141E-01	0.	0.
56	2.67019	0.00000	-2.93403	.68608E-03	-.34725E-01	-.34160E-01	0.	0.
57	3.55572	0.00000	-2.93403	.64898E-03	-.34711E-01	-.34177E-01	0.	0.
58	1.96912	0.00000	-3.40158	.72815E-03	-.25908E-01	-.25290E-01	0.	0.
59	2.76467	0.00000	-3.40158	.69164E-03	-.25895E-01	-.25309E-01	0.	0.
60	3.56022	0.00000	-3.40158	.65783E-03	-.25883E-01	-.25326E-01	0.	0.

CONTROL POINT COORDINATES FOR HIR*9 (WING FRAME)

J	X(J)	Y(J)	Z(J)	THU(J)	THV(J)	THW(J)
61	1.14000	1.25052	.24874	-.13891E-02	-.18221E-01	.34655E-02
62	1.14000	1.06014	.70836	-.15717E-01	-.88792E-02	.20553E-01
63	1.14000	.70836	1.06014	-.15717E-01	.20553E-01	-.88792E-02
64	1.14000	.24874	1.25052	-.13891E-02	.34655E-02	-.18221E-01
65	1.14000	-.24874	1.25052	-.13891E-02	-.34655E-02	-.18221E-01
66	1.14000	-.70836	1.06014	-.15717E-01	-.20553E-01	-.88792E-02
67	1.14000	-1.06014	.70836	-.15717E-01	.88792E-02	.20553E-01
68	1.14000	-1.25052	.24874	-.13891E-02	.18221E-01	.34655E-02
69	1.14000	-1.25052	-.24874	-.13891E-02	.18221E-01	-.34655E-02
70	1.14000	-1.06014	-.70836	-.15717E-01	.88792E-02	-.20553E-01
71	1.14000	-.70836	-1.06014	-.15717E-01	-.20553E-01	.88792E-02
72	1.14000	-.24874	-1.25052	-.13891E-02	-.34655E-02	.18221E-01
73	1.14000	.24874	-1.25052	-.13891E-02	.34655E-02	.18221E-01
74	1.14000	.70836	-1.06014	-.15717E-01	.20553E-01	.88792E-02
75	1.14000	1.06014	-.70836	-.15717E-01	-.88792E-02	-.20553E-01
76	1.14000	1.25052	-.24874	-.13891E-02	-.18221E-01	-.34655E-02
77	2.34000	1.25052	.24874	-.10403E-01	-.31303E-02	-.54293E-02
78	2.34000	1.06014	.70836	-.71993E-02	.60701E-03	-.75132E-02
79	2.34000	.70836	1.06014	-.71993E-02	-.75132E-02	.60701E-03
80	2.34000	.24874	1.25052	-.10403E-01	-.54293E-02	-.31303E-02
81	2.34000	-.24874	1.25052	-.10403E-01	.54293E-02	-.31303E-02
82	2.34000	-.70836	1.06014	-.71993E-02	.75132E-02	.60701E-03

Figure 18.- Continued.

83	2.34000	-1.06014	.70836	-.71993E-02	-.60701E-03	-.75132E-02
84	2.34000	-1.25052	.24874	-.10403E-01	.31303E-02	-.54293E-02
85	2.34000	-1.25052	-.24874	-.10403E-01	.31303E-02	.54293E-02
86	2.34000	-1.06014	-.70836	-.71993E-02	-.60701E-03	.75132E-02
87	2.34000	-.70836	-1.06014	-.71993E-02	.75132E-02	-.60701E-03
88	2.34000	-.24874	-1.25052	-.10403E-01	.54293E-02	.31303E-02
89	2.34000	.24874	-1.25052	-.10403E-01	-.54293E-02	.31303E-02
90	2.34000	.70836	-1.06014	-.71993E-02	-.75132E-02	-.60701E-03
91	2.34000	1.06014	-.70836	-.71993E-02	.60701E-03	.75132E-02
92	2.34000	1.25052	-.24874	-.10403E-01	-.31303E-02	.54293E-02
93	3.54000	1.25052	.24874	.26703E-01	.18903E-01	-.45436E-01
94	3.54000	1.06014	.70836	-.26070E-01	.94557E-02	.92392E-02
95	3.54000	.70836	1.06014	-.26070E-01	.92392E-02	.94557E-02
96	3.54000	.24874	1.25052	.26703E-01	-.45436E-01	.18903E-01
97	3.54000	-.24874	1.25052	.26703E-01	.45436E-01	.18903E-01
98	3.54000	-.70836	1.06014	-.26070E-01	-.92392E-02	.94557E-02
99	3.54000	-1.06014	.70836	-.26070E-01	-.94557E-02	.92392E-02
100	3.54000	-1.25052	.24874	.26703E-01	-.18903E-01	-.45436E-01
101	3.54000	-1.25052	-.24874	.26703E-01	-.18903E-01	.45436E-01
102	3.54000	-1.06014	-.70836	-.26070E-01	-.94557E-02	-.92392E-02
103	3.54000	-.70836	-1.06014	-.26070E-01	-.92392E-02	-.94557E-02
104	3.54000	-.24874	-1.25052	.26703E-01	.45436E-01	-.18903E-01
105	3.54000	.24874	-1.25052	.26703E-01	-.45436E-01	-.18903E-01
106	3.54000	.70836	-1.06014	-.26070E-01	.92392E-02	-.94557E-02
107	3.54000	1.06014	-.70836	-.26070E-01	.94557E-02	-.92392E-02
108	3.54000	1.25052	-.24874	.26703E-01	.18903E-01	.45436E-01

LOADING INFORMATION

MACH NUMBER = .17000E+01
ANGLE OF ATTACK = 10.000 DEGREES
SIDE SLIP ANGLE = 10.000 DEGREES
WING AREA = 13.48666
REFERENCE AREA = 5.30929
REFERENCE LENGTH = 2.69000
EXPOSED WING SPAN B = 4.68000
MOMENT CENTER: XM = 19.50000
ZM = 0.00000

U/VINF TYPE LOADING PRESSURE

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
DEFL. ANGLE DEG. =		0.00000	0.00000	0.00000	0.00000	
CTHR =	.30615E-01	.10495E-01	.48137E-02	.48118E-02	.10495E-01	
CZ =	.10224E+01	.58122E+00	.28949E+00	0.	0.	.15172E+00
CY =	-.10223E+01	0.	0.	-.28940E+00	-.58123E+00	-.15171E+00
CM =	-.69633E+01	-.39520E+01	-.19585E+01	0.	0.	-.10528E+01
CLN =	.69626E+01	0.	0.	.19578E+01	.39521E+01	.10527E+01
CLL =	.91616E-04	-.50670E+00	.27706E+00	-.27698E+00	.50671E+00	.87696E-16

Figure 18.- Continued.

FOLLOWING ARE IN WIND-AXIS SYSTEM

CL =	.14091E+01	.40098E+00	.19962E+00	.19956E+00	.40099E+00	.20799E+00
CY-IND =	.66084E-04	.41099E+00	.20470E+00	-.20464E+00	-.41099E+00	.99703E-05
CDI =	.32540E+00	.90756E-01	.45604E-01	.45591E-01	.90758E-01	.52691E-01
CDI/CL**2 =	.16308E+00					
CM-IND =	-.98471E+01	-.27945E+01	-.13848E+01	-.13844E+01	-.27945E+01	-.14888E+01
CLN-IND =	-.45862E-03	-.25845E+01	-.14105E+01	.14100E+01	.25845E+01	-.66543E-04

NOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW IS SUPERSONIC

--------------------RIGHT WING--------------------

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
1	.65426	.16708	0.00000	0.00000	.00025	0.00000	0.00000	0.00000	-.78235	0.00000	.13334
2	.85415	.16341	0.00000	0.00000	.00112	0.00000	0.00000	0.00000	.01711	0.00000	.40340
3	1.05402	.15153	0.00000	0.00000	.00153	0.00000	0.00000	0.00000	.05558	0.00000	.67342
4	1.25386	.12992	0.00000	0.00000	.00167	0.00000	0.00000	0.00000	.10112	0.00000	.94341
5	1.45367	.09252	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.17509	0.00000	1.21335
6	1.55556	0.00000							.43345		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = .37762E-02
SUMFT2 = .23655E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	.00354	.00063	3.64000	1.35100
2	2	.66667	.03255	.00640	3.64000	2.10067
3	3	1.00000	.03840	.01321	3.64000	2.85033

Figure 18.- Continued.

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Y.C.G.
1	.78196	3.27319

******************* LEFT WING**********************

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
7	-.65426	.04806	0.00000	0.00000	-.00151	0.00000	0.00000	0.00000	.22503	0.00000	.13334
8	-.85415	.06115	0.00000	0.00000	-.00066	0.00000	0.00000	0.00000	.06133	0.00000	.40340
9	-1.05402	.07844	0.00000	0.00000	-.00010	0.00000	0.00000	0.00000	.08102	0.00000	.67342
10	-1.25386	.08807	0.00000	0.00000	-.00038	0.00000	0.00000	0.00000	.04513	0.00000	.94341
11	-1.45367	.07516	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.06041	0.00000	1.21335
12	-1.55556	0.00000							-.35211		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = -.21914E-02
SUMFT2 = -.23666E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	-.00686	-.00122	-3.64000	1.35100
2	2	.66667	-.03686	-.00776	-3.64000	2.10067
3	3	1.00000	-.03080	-.01322	-3.64000	2.85033

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Y.C.G.
2	.18725	-2.19543
3	-.41216	-3.57139

Figure 18.- Continued.

--------------------UPPER WING--------------------

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
13	.65026	.04804	0.00000	0.00000	.00151	0.00000	0.00000	0.00000	-.22494	0.00000	.13334
14	.85415	.06113	0.00010	0.00000	.00066	0.00000	0.00000	0.00000	-.06131	0.00000	.40340
15	1.05402	.07842	0.00000	0.00000	.00010	0.00000	0.00000	0.00000	-.08190	0.00000	.67342
16	1.25386	.08404	0.00000	0.00000	.00038	0.00000	0.00000	0.00000	-.04515	0.00000	.94341
17	1.45367	.07514	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.06035	0.00000	1.21335
18	1.55556	0.00000							.35205		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = .21909E-02
SUMFT2 = .23662E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	4	.33333	.00687	.00122	3.64000	1.35100
2	5	.66667	.03686	.00776	3.64000	2.10067
3	6	1.00000	.03079	.01322	3.64000	2.85033

*****T.E. FIN VORTEX INFO******

IVRT	GAMMA/VINF	Z.C.G.
4	-.18721	2.19551
5	.41204	3.57143

Figure 18.- Continued.

******************LOWER WING******************

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LE/VINF	
19	-.65426	.16709	0.00000	0.00000	-.00025	0.00000	0.00000	0.00000	.78236	0.00000	[illegible]
20	-.85415	.16342	0.00000	0.00000	-.00112	0.00000	0.00000	0.00000	-.01711	0.00000	[illegible]
21	-1.05402	.15153	0.00000	0.00000	-.00153	0.00000	0.00000	0.00000	-.05557	0.00000	[illegible]
22	-1.25386	.12992	0.00000	0.00000	-.00167	0.00000	0.00000	0.00000	-.10112	0.00000	[illegible]
23	-1.45367	.09252	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.17509	0.00000	1.[illegible]
24	-1.55556	0.00000							-.43346		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = -.37762E-02
SUMFT2 = -.23656E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	7	.33333	-.00354	-.00063	-3.64000	1.35100
2	8	.66667	-.03255	-.00640	-3.64000	2.10067
3	9	1.00000	-.03840	-.01321	-3.64000	2.85033

*****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Z,C.G.
6	-.78196	-3.27321

VELOCITIES AND BERNOULLI PRESSURES AT CONTROL POINTS IMMEDIATELY ABOVE AND BELOW HORIZONTAL WING SURFACE

J	X(J)	Y(J)	Z(J)	UTOTA	VTOTA	WTOTA	PRESSA	UTOTB	VTOTB	WTOTB	PRESSB
1	1.231118	1.530959	0.000000	.129145	.068203	-.173650	-.185699	-.129028	.217259	-.173650	.358780
2	2.386670	1.530959	0.000000	.101384	.088861	-.173650	-.137395	-.107142	.169123	-.173650	.307666
3	3.542222	1.530959	0.000000	.150268	.168505	-.314650	-.223650	-.060070	.208985	-.032659	.169474
4	1.415654	1.998701	0.000000	.152781	-.031297	-.173650	-.241259	-.138562	.136910	-.173650	.383371
5	2.481188	1.998701	0.000000	.113561	.058478	-.173650	-.162344	-.109953	.144508	-.173650	.313347

Figure 18.- Continued.

6	3,546723	1,998701	0,000000	,161209	,126025	-,314650	-,240721	-,042107	,165153	-,032650	,131624
7	1,600170	2,466397	0,000000	,191832	-,054983	-,173650	-,297720	-,110893	,119796	-,173650	,312729
8	2,575697	2,466397	0,000000	,129801	,030109	-,173650	-,193434	-,116276	,124824	-,173650	,326621
9	3,551224	2,466397	0,000000	,206539	,076211	-,314650	-,303594	,027879	,110594	-,032650	-,018133
10	1,784662	2,934030	0,000000	,148754	,003172	-,173650	-,227381	-,155865	,179044	-,173650	,429061
11	2,670193	2,934030	0,000000	,167200	,012209	-,173650	-,251417	-,080142	,107411	-,173650	,237021
12	3,555723	2,934030	0,000000	,209438	,100777	-,314650	-,304929	,074199	,126803	-,032650	-,102489
13	1,969121	3,401580	0,000000	,157981	,032492	-,173650	-,234765	-,122717	,194553	-,173650	,345299
14	2,764672	3,401580	0,000000	,004232	,026653	-,173650	-,153399	-,061653	,090537	-,173650	,190837
15	3,560222	3,401580	0,000000	,101604	,046797	-,314650	-,160045	,003357	,065704	-,032650	,022616
16	1,231118	-1,530959	0,000000	,037972	,181557	-,173650	-,014657	-,035365	,139216	-,173650	,138411
17	2,386670	-1,530959	0,000000	,034291	,181043	-,173650	-,007363	-,045334	,150396	-,173650	,161572
18	3,542222	-1,530959	0,000000	,120857	,146280	-,314650	-,185776	,083083	,138240	-,032650	-,117261
19	1,415654	-1,998701	0,000000	,063527	,222175	-,173650	-,065850	-,046249	,156796	-,173650	,164037
20	2,481188	-1,998701	0,000000	,060120	,168307	-,173650	-,057546	-,039398	,130002	-,173650	,146557
21	3,546723	-1,998701	0,000000	,137855	,143383	-,314650	-,205846	,078405	,131942	-,032650	-,109508
22	1,600170	-2,466397	0,000000	,127203	,218985	-,173650	-,176074	-,046454	,118724	-,173650	,161075
23	2,575697	-2,466397	0,000000	,075503	,162503	-,173650	-,085958	-,058974	,110743	-,173650	,188398
24	3,551224	-2,466397	0,000000	,154574	,136506	-,314650	-,230745	,086113	,123330	-,032650	-,123540
25	1,784662	-2,934030	0,000000	,119560	,145998	-,173650	-,162743	-,126882	,003715	-,173650	,314459
26	2,670193	-2,934030	0,000000	,126540	,156456	-,173650	-,173723	-,036527	,093692	-,173650	,134796
27	3,555723	-2,934030	0,000000	,177642	,105272	-,314650	-,264600	,121313	,094432	-,032650	-,184191
28	1,969121	-3,401580	0,000000	,155547	,096988	-,173650	-,222228	-,120515	-,062396	-,173650	,262251
29	2,764672	-3,401580	0,000000	,079984	,106955	-,173650	-,097793	-,037631	,061685	-,173650	,129956
30	3,560222	-3,401580	0,000000	,078544	,109215	-,314650	-,111764	,029624	,099801	-,032650	-,022946

VELOCITIES AND BERNOULLI PRESSURES AT CONTROL POINTS IMMEDIATELY TO RIGHT AND LEFT OF VERTICAL WING SURFACE

J	X(J)	Y(J)	Z(J)	UTOTR	VTOTR	WTOTR	PRESSR	UTOTL	VTOTL	WTOTL	PRESSL
31	1,231118	0,000000	1,530959	-,035346	,173650	-,139216	,138369	,037954	,173650	-,181535	-,014620
32	2,386670	0,000000	1,530959	-,045320	,173650	-,150384	,161541	,034277	,173650	-,181021	-,007336
33	3,542222	0,000000	1,530959	,083091	,314650	-,138222	-,117276	,124856	,032650	-,146260	-,185776
34	1,415654	0,000000	1,998701	-,046223	,173650	-,158802	,163978	,063501	,173650	-,222151	-,065799
35	2,481188	0,000000	1,998701	-,039379	,173650	-,129985	,146515	,060103	,173650	-,168275	-,057314
36	3,546723	0,000000	1,998701	,078414	,314650	-,131906	-,109527	,137850	,032650	-,143344	-,205841
37	1,600170	0,000000	2,466397	-,046425	,173650	-,118760	,161013	,127173	,173650	-,218987	-,176027
38	2,575697	0,000000	2,466397	-,058953	,173650	-,110761	,188352	,075492	,173650	-,162505	-,085919
39	3,551224	0,000000	2,466397	,086130	,314650	-,123323	-,123571	,154557	,032650	-,134492	-,230721
40	1,784662	0,000000	2,934030	-,126859	,173650	-,003770	,314432	,119538	,173650	-,146027	-,162704
41	2,670193	0,000000	2,934030	-,036504	,173650	-,093750	,134756	,126517	,173650	-,156498	-,173685
42	3,555723	0,000000	2,934030	,121337	,314650	-,098493	-,184220	,177619	,032650	-,105325	-,264566
43	1,969121	0,000000	3,401580	-,120505	,173650	,062352	,262256	,155537	,173650	-,097021	-,222210
44	2,764672	0,000000	3,401580	-,037616	,173650	-,061740	,129938	,079969	,173650	-,106998	-,097761
45	3,560222	0,000000	3,401580	,029638	,314650	-,099867	-,022964	,078530	,032650	-,109277	-,111733
46	1,231118	0,000000	-1,530959	-,129027	,173650	-,217264	,358778	,129144	,173650	-,068208	-,185697
47	2,386670	0,000000	-1,530959	-,107144	,173650	-,169127	,307672	,101386	,173650	-,068864	-,137399
48	3,542222	0,000000	-1,530959	-,060075	,314650	-,208990	,169483	,150266	,032650	-,168510	-,223645
49	1,415654	0,000000	-1,998701	-,138563	,173650	-,136918	,383375	,152782	,173650	,031290	-,241259
50	2,481188	0,000000	-1,998701	-,109956	,173650	-,144516	,313356	,113563	,173650	-,058483	-,162346
51	3,546723	0,000000	-1,998701	-,042110	,314650	-,165161	,131032	,161207	,032650	-,126033	-,240718
52	1,600170	0,000000	-2,466397	-,110897	,173650	-,119804	,312738	,191836	,173650	,054979	-,297723
53	2,575697	0,000000	-2,466397	-,116279	,173650	-,124831	,326630	,129804	,173650	-,030114	-,193437
54	3,551224	0,000000	-2,466397	,027877	,314650	-,110599	-,016130	,206540	,032650	-,076215	-,303595
55	1,784662	0,000000	-2,934030	-,155870	,173650	-,179050	,429074	,148759	,173650	-,003172	-,227388
56	2,670193	0,000000	-2,934030	-,080145	,173650	-,107415	,237028	,167202	,173650	-,012211	-,251420
57	3,555723	0,000000	-2,934030	,074198	,314650	-,126807	-,102485	,209039	,032650	-,100780	-,304930

Figure 18.- Continued.

58	1.969121	0.000000	-3.401580	-.122722	.173650	-.194557	.345311	.157986	.173650	-.032490	-.234773
59	2.764672	0.000000	-3.401580	-.061665	.173650	-.090509	.190841	.104234	.173650	-.026654	-.153402
60	3.560222	0.000000	-3.401580	.003356	.314650	-.065706	.022617	.101604	.032650	-.046798	-.160046

PRESSURE LOADINGS AT CONTROL POINTS

J	X(J)	Y(J)	Z(J)	DELTP,LIN,	DELTP,BERN,
1	1.231118	1.530959	0.000000	.516345	.544479
2	2.386670	1.530959	0.000000	.417051	.445061
3	3.542222	1.530959	0.000000	.420677	.393123
4	1.415654	1.998701	0.000000	.562686	.624629
5	2.481188	1.998701	0.000000	.447027	.475691
6	3.546723	1.998701	0.000000	.406632	.371745
7	1.600170	2.466397	0.000000	.605451	.610449
8	2.575697	2.466397	0.000000	.492153	.520055
9	3.551224	2.466397	0.000000	.357319	.285461
10	1.784662	2.934030	0.000000	.609237	.656443
11	2.670193	2.934030	0.000000	.494683	.488438
12	3.555723	2.934030	0.000000	.270477	.202441
13	1.969121	3.401580	0.000000	.561396	.580064
14	2.764672	3.401580	0.000000	.331792	.344236
15	3.560222	3.401580	0.000000	.196493	.182661
16	1.231118	-1.530959	0.000000	.146674	.153068
17	2.386670	-1.530959	0.000000	.159248	.168935
18	3.542222	-1.530959	0.000000	.084548	.068515
19	1.415654	-1.998701	0.000000	.219553	.229887
20	2.481188	-1.998701	0.000000	.199036	.203903
21	3.546723	-1.998701	0.000000	.118900	.096358
22	1.600170	-2.466397	0.000000	.347314	.337149
23	2.575697	-2.466397	0.000000	.268955	.274356
24	3.551224	-2.466397	0.000000	.136922	.107204
25	1.784662	-2.934030	0.000000	.492884	.477202
26	2.670193	-2.934030	0.000000	.326135	.308519
27	3.555723	-2.934030	0.000000	.112657	.080410
28	1.969121	-3.401580	0.000000	.552124	.484479
29	2.764672	-3.401580	0.000000	.235230	.227749
30	3.560222	-3.401580	0.000000	.097841	.088818
31	1.231118	0.000000	1.530959	.146599	.152989
32	2.386670	0.000000	1.530959	.159195	.168877
33	3.542222	0.000000	1.530959	.084531	.068500
34	1.415654	0.000000	1.998701	.219449	.229778
35	2.481188	0.000000	1.998701	.198965	.203828
36	3.546723	0.000000	1.998701	.118871	.096314
37	1.600170	0.000000	2.466397	.347196	.337040
38	2.575697	0.000000	2.466397	.268869	.274270
39	3.551224	0.000000	2.466397	.136853	.107149
40	1.784662	0.000000	2.934030	.492793	.477136
41	2.670193	0.000000	2.934030	.326044	.308442
42	3.555723	0.000000	2.934030	.112565	.080346
43	1.969121	0.000000	3.401580	.552084	.484466
44	2.764672	0.000000	3.401580	.235170	.227699
45	3.560222	0.000000	3.401580	.097785	.088768
46	1.231118	0.000000	-1.530959	.516343	.544475
47	2.386670	0.000000	-1.530959	.417060	.445070
48	3.542222	0.000000	-1.530959	.420680	.393128
49	1.415654	0.000000	-1.998701	.582691	.624634

Figure 18.- Continued.

50	2.481188	0.000000	-1.998701	.447038	.475702
51	3.546725	0.000000	-1.998701	.406635	.371749
52	1.600170	0.000000	-2.466397	.505465	.610461
53	2.575697	0.000000	-2.466397	.492166	.520067
54	3.551224	0.000000	-2.466397	.357326	.285466
55	1.784662	0.000000	-2.934030	.609257	.656462
56	2.670193	0.000000	-2.934030	.494694	.488448
57	3.555723	0.000000	-2.934030	.270462	.202445
58	1.969121	0.000000	-3.401580	.561416	.580084
59	2.764672	0.000000	-3.401580	.331799	.344244
60	3.560222	0.000000	-3.401580	.196496	.182664

LOADING INFORMATION

MACH NUMBER = .17000E+01
ANGLE OF ATTACK = 10.000 DEGREES
SIDE SLIP ANGLE = 10.000 DEGREES
WING AREA = 13.68666
REFERENCE AREA = 5.30929
REFERENCE LENGTH = 2.69000
EXPOSED WING SPAN B = 4.68000
MOMENT CENTER: XM = 19.50000
ZM = 0.00000

BERNOUILLI TYPE LOADING PRESSURE

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
DEFL. ANGLE DEG. =		0.00000	0.00000	0.00000	0.00000	
CTHP =	.29847E+01	.10546E-01	.43780E-02	.43764E-02	.10546E-01	
CZ =	.10099E+01	.58324E+00	.27494E+00	0.	0.	.15172E+00
CY =	-.10098E+01	0.	0.	-.27486E+00	-.58325E+00	-.15171E+00
CM =	-.66836E+01	-.39542E+01	-.18559E+01	0.	0.	-.10528E+01
CLN =	.48624E+01	0.	0.	.18554E+01	.[illegible]543E+01	.10527E+01
CLL =	.80597E-04	-.50701E+00	.26086E+00	-.26079E+00	[illegible]	.87696E-16

FOLLOWING ARE IN WIND-AXIS SYSTEM

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
CL =	.13918E+01	.40237E+00	.18953E+00	.18948E+00	.40238E+00	.20799E+00
CY*IND =	.59651E-04	.41241E+00	.19441E+00	-.19436E+00	-.41242E+00	.99703E-05
CDI =	.32179E+00	.91056E-01	.43500E-01	.43487E-01	.91058E-01	.52691E-01
CDI/CL**2 =	.16613E+00					
CM*IND =	-.97053E+01	-.27960E+01	-.13123E+01	-.13120E+01	-.27961E+01	-.14888E+01
CLN*IND =	-.41251E-03	-.25850E+01	-.13362E+01	.13358E+01	.25860E+01	-.66543E-04

NOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW IS SUPERSONIC

Figure 18.- Continued.

--------------------RIGHT WING--------------------

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*H)	CT*C/(2*H)	CY1*C/(2*B)	CYTOT*C/(2*H)	CS*C/(2*H)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
1	.65426	.17051	0.00000	0.00000	.00017	0.00000	0.00000	0.00000	-.79887	0.00000	.13334
2	.85415	.16738	0.00000	0.00000	.00207	0.00000	0.00000	0.00000	.01460	0.00000	.40340
3	1.05402	.14747	0.00000	0.00000	.00146	0.00000	0.00000	0.00000	.09361	0.00000	.67342
4	1.25386	.12736	0.00000	0.00000	.00146	0.00000	0.00000	0.00000	.09411	0.00000	.94341
5	1.45367	.09399	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.15623	0.00000	1.21335
6	1.55556	0.00000							.44032		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = .42571E-02
SUMFT2 = .24246E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	.00366	.00065	3.64000	1.35100
2	2	.66667	.03368	.00662	3.64000	2.10067
3	3	1.00000	.03901	.01354	3.64000	2.85033

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Y.C.G.
1	.79846	3.23908

Figure 18.- Continued.

-------------------- LEFT WING ----------------------

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
7	-.65426	.04819	0.00000	0.00000	-.00150	0.00000	0.00000	0.00000	.22563	0.00000	.13334
8	-.85415	.06031	0.00000	0.00000	-.00056	0.00000	0.00000	0.00000	.05680	0.00000	.40340
9	-1.05402	.07485	0.00000	0.00000	-.00007	0.00000	0.00000	0.00000	.06813	0.00000	.67342
10	-1.25386	.08187	0.00000	0.00000	-.00066	0.00000	-0.00000	0.00000	.03293	0.00000	.94341
11	-1.45367	.06891	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.06486	0.00000	1.21335
12	-1.55556	0.00000							-.31864		

SUMFX = 0.
SUMFY1 = 0.
SUMFY2 = -.22984E-02
SUMFT2 = -.21352E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.33333	-.00602	-.00107	-3.64000	1.35100
2	2	.66667	-.03334	-.00698	-3.64000	2.10067
3	3	1.00000	-.02787	-.01193	-3.64000	2.85033

*****T.F. FIN VORTEX INFO******

IVRT	GAMMA/VINF	Y.C.G.
2	.15764	-2.16505
3	-.38316	-3.56077

Figure 18.- Continued.

```
--------------------UPPER WING---------------------
```

SPANWISE DISTRIBUTIONS--

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	[illegible]FT(I)	GAMMA,LE/VINF	XLE
13	.65426	.04817	0.00000	0.00000	.00150	0.00000	0.00000	0.00000	-.22554	0.00000	.13334
14	.85415	.06029	0.00000	0.00000	.00056	0.00000	0.00000	0.00000	-.05678	0.00000	.40340
15	1.05402	.07483	0.00000	0.00000	.00007	0.00000	0.00000	0.00000	-.06811	0.00000	.67342
16	1.25386	.08185	0.00000	0.00000	.00066	0.00000	0.00000	0.00000	-.03296	0.00000	.94341
17	1.45367	.06800	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.06481	0.00000	1.21335
18	1.55556	0.00000							.31859		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = .22978E-02
SUMFT2 = .21549E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	4	.33333	.00602	.00107	3.64000	1.35100
2	5	.66667	.03334	.00698	3.64000	2.10067
3	6	1.00000	.02787	.01193	3.64000	2.85033

*****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Z.C.G.
4	-.19764	2.16521
5	.38307	3.56081

Figure 18.- Continued.

-------------------LOWER WING-------------------

SPANWISE DISTRIBUTIONS

I	Z/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CZ1*C/(2*B)	CZTOT*C/(2*B)	CS*C/(2*B)	CSINT	ZBAR	GAMNET(I)	GAMMA,LE/VINF	XLF
19	-.65426	.17061	0.00000	0.00000	-.00017	0.00000	0.00000	0.00000	.79888	0.00000	.13334
20	-.85015	.16738	0.00000	0.00000	-.00207	0.00000	0.00000	0.00000	-.01460	0.00000	.40340
21	-1.05402	.14747	0.00000	0.00000	-.00146	0.00000	0.00000	0.00000	-.09361	0.00000	.67342
22	-1.25386	.12736	0.00000	0.00000	-.00146	0.00000	0.00000	0.00000	-.09411	0.00000	.94341
23	-1.45367	.09399	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-.15623	0.00000	1.21335
24	-1.55556	0.00000							-.44033		

SUMFX = 0.
SUMFZ1 = 0.
SUMFZ2 = -.42571E-02
SUMFT2 = -.24247E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	ZBAR	XSE
1	7	.33333	-.00366	-.00065	-3.64000	1.35100
2	8	.66667	-.03368	-.00642	-3.64000	2.10067
3	9	1.00000	-.03901	-.01354	-3.64000	2.85033

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Z.C.G.
6	-.79847	-3.23910

****
AFT OF LEADING EDGE OF FIN ROOTCHORDS

Figure 18.- Continued.

PRESSURE COEFFICIENTS AT POINTS ON BODY MERIDIANS

BODY RING= 1

J	THETA, DEG.	XH	YH.	ZH	UTOT	VTOT	WTOT	CP,LIN,	CP,HERN,	DR/DX	P/PINF, HERN,	P/PINF, LIN,
1	11,25000	36,54000	1,25052	,24874	,08219	,13852	,01640	-,16438	-,12894	0,00000	,73915	,66747
2	33,75000	36,54000	1,06014	,70836	,01475	,03202	,03127	-,02949	-,02988	0,00000	,93955	,94034
3	56,25000	36,54000	,70836	1,06014	-,02327	,06871	-,10981	,04655	,09578	0,00000	1,19375	1,09416
4	78,75000	36,54000	,24874	1,25052	-,03442	,11770	-,16598	,06884	,13393	0,00000	1,27093	1,13926
5	101,25000	36,54000	-,24874	1,25052	,01842	,17193	-,18030	-,03685	,02463	0,00000	1,04982	,92546
6	123,75000	36,54000	-,70836	1,06014	-,00634	,18091	-,17097	,01267	,07637	0,00000	1,15449	1,02564
7	146,25000	36,54000	-1,06014	,70836	-,00633	,17099	-,18087	,01266	,07636	0,00000	1,15448	1,02562
8	168,75000	36,54000	-1,25052	,24874	,01844	,18031	-,17190	-,03688	,02460	0,00000	1,04977	,92540
9	191,25000	36,54000	-1,25052	-,24874	-,03443	,16598	-,11769	,06887	,13396	0,00000	1,27099	1,13932
10	213,75000	36,54000	-1,06014	-,70836	-,02328	,10984	-,06876	,04655	,09580	0,00000	1,19381	1,09418
11	236,25000	36,54000	-,70836	-1,06014	,01475	-,03123	-,03205	-,02949	-,02986	0,00000	,93959	,94034
12	258,75000	36,54000	-,24874	-1,25052	,08219	-,01638	-,13852	-,16437	-,12894	0,00000	,73916	,66747
13	281,25000	36,54000	,24874	-1,25052	-,09828	,06821	-,20246	,19656	,26977	0,00000	1,54575	1,39765
14	303,75000	36,54000	,70836	-1,06014	-,04277	,15795	-,19643	,08555	,15552	0,00000	1,31462	1,17307
15	326,25000	36,54000	1,06014	-,70836	-,04277	,19642	-,15796	,08555	,15552	0,00000	1,31462	1,17307
16	348,75000	36,54000	1,25052	-,24874	-,09828	,20246	-,06821	,19656	,26977	0,00000	1,54575	1,39765

BODY RING= 2

J	THETA, DEG.	XH	YH.	ZH	UTOT	VTOT	WTOT	CP,LIN,	CP,HERN,	DR/DX	P/PINF, HERN,	P/PINF, LIN,
1	11,25000	37,74000	1,25052	,24874	,09340	,14188	,00241	-,18680	-,14353	0,00000	,70965	,62210
2	33,75000	37,74000	1,06014	,70836	,05033	,06741	-,02045	-,10067	-,07064	0,00000	,85710	,79635
3	56,25000	37,74000	,70836	1,06014	-,00353	,07850	-,11769	,00705	,05716	0,00000	1,11564	1,01427
4	78,75000	37,74000	,24874	1,25052	-,03836	,12796	-,16918	,07671	,14399	0,00000	1,29128	1,15519
5	101,25000	37,74000	-,24874	1,25052	,03431	,19227	-,17615	-,06861	-,00769	0,00000	,98444	,86120
6	123,75000	37,74000	-,70836	1,06014	,02468	,21202	-,14964	-,04935	,00988	0,00000	1,01998	,90016
7	146,25000	37,74000	-1,06014	,70836	,02468	,14967	-,21198	-,04937	,00987	0,00000	1,01997	,90013
8	168,75000	37,74000	-1,25052	,24874	,03432	,17615	-,19224	-,06864	-,00771	0,00000	,98439	,86114
9	191,25000	37,74000	-1,25052	-,24874	-,03837	,16918	-,12799	,07674	,14402	0,00000	1,29135	1,15525
10	213,75000	37,74000	-1,06014	-,70836	-,00354	,11774	-,07857	,00708	,05721	0,00000	1,11573	1,01431
11	236,25000	37,74000	-,70836	-1,06014	,05033	,02048	-,06743	-,10066	-,07062	0,00000	,85714	,79636
12	258,75000	37,74000	-,24874	-1,25052	,09340	-,00239	-,14188	-,18680	-,14352	0,00000	,70965	,62210
13	281,25000	37,74000	,24874	-1,25052	-,11208	,05872	-,20464	,22416	,29970	0,00000	1,60630	1,45348
14	303,75000	37,74000	,70836	-1,06014	-,12123	,14059	-,20823	,24245	,33892	0,00000	1,68564	1,49048
15	326,25000	37,74000	1,06014	-,70836	-,12122	,20823	-,14060	,24245	,33892	0,00000	1,68564	1,49048
16	348,75000	37,74000	1,25052	-,24874	-,11208	,20464	-,05872	,22416	,29970	0,00000	1,60630	1,45348

BODY RING= 3

J	THETA, DEG.	XH	YH.	ZH	UTOT	VTOT	WTOT	CP,LIN,	CP,HERN,	DR/DX	P/PINF, HERN,	P/PINF, LIN,
1	11,25000	38,94000	1,25052	,24874	,10902	,15137	-,04299	-,21804	-,15818	0,00000	,68000	,55890
2	33,75000	38,94000	1,06014	,70836	,03374	,07278	-,02726	-,06749	-,03683	0,00000	,92549	[illegible]
3	56,25000	38,94000	,70836	1,06014	,00734	,08662	-,12365	-,01469	,03689	0,00000	1,07462	,98029
4	78,75000	38,94000	,24874	1,25052	,03709	,08564	-,16211	-,07418	-,02054	0,00000	,95845	[illegible]
5	101,25000	38,94000	-,24874	1,25052	,08829	,23668	-,16751	-,17657	-,11217	0,00000	,77308	,64280
6	123,75000	38,94000	-,70836	1,06014	,05319	,20442	-,15419	-,10638	-,04540	0,00000	,90816	,78479
7	146,25000	38,94000	-1,06014	,70836	,05319	,15421	-,20438	-,10638	-,04539	0,00000	,90817	,78479
8	168,75000	38,94000	-1,25052	,24874	,08829	,16751	-,23665	-,17657	-,11217	0,00000	,77309	,64279
9	191,25000	38,94000	-1,25052	-,24874	,03708	,16211	-,08567	-,07416	-,02052	0,00000	,95848	,84997
10	213,75000	38,94000	-1,06014	-,70836	,00734	,12369	-,08668	-,01467	,03692	0,00000	1,07469	,97032

Figure 18.- Continued.

11	236.25000	38.94000	-.70836	-1.06014	.03373	.02729	-.07281	-.06747	-.03680	0.00000	.92555	.86351
12	258.75000	38.94000	-.24874	-1.25052	.10902	.04299	-.15137	-.21803	-.15817	0.00000	.68002	.55892
13	281.25000	38.94000	.24874	-1.25052	-.09663	-.00224	-.21700	.19326	.23784	0.00000	1.48116	1.39096
14	303.75000	38.94000	.70836	-1.06014	-.15488	.13903	-.20945	.30977	.42275	0.00000	1.85523	1.62666
15	326.25000	38.94000	1.06014	-.70836	-.15488	.20944	-.13904	.30977	.42275	0.00000	1.85523	1.62666
16	348.75000	38.94000	1.25052	-.24874	-.09663	.21700	.00223	.19325	.23784	0.00000	1.48115	1.39095

Figure 18.- Concluded.

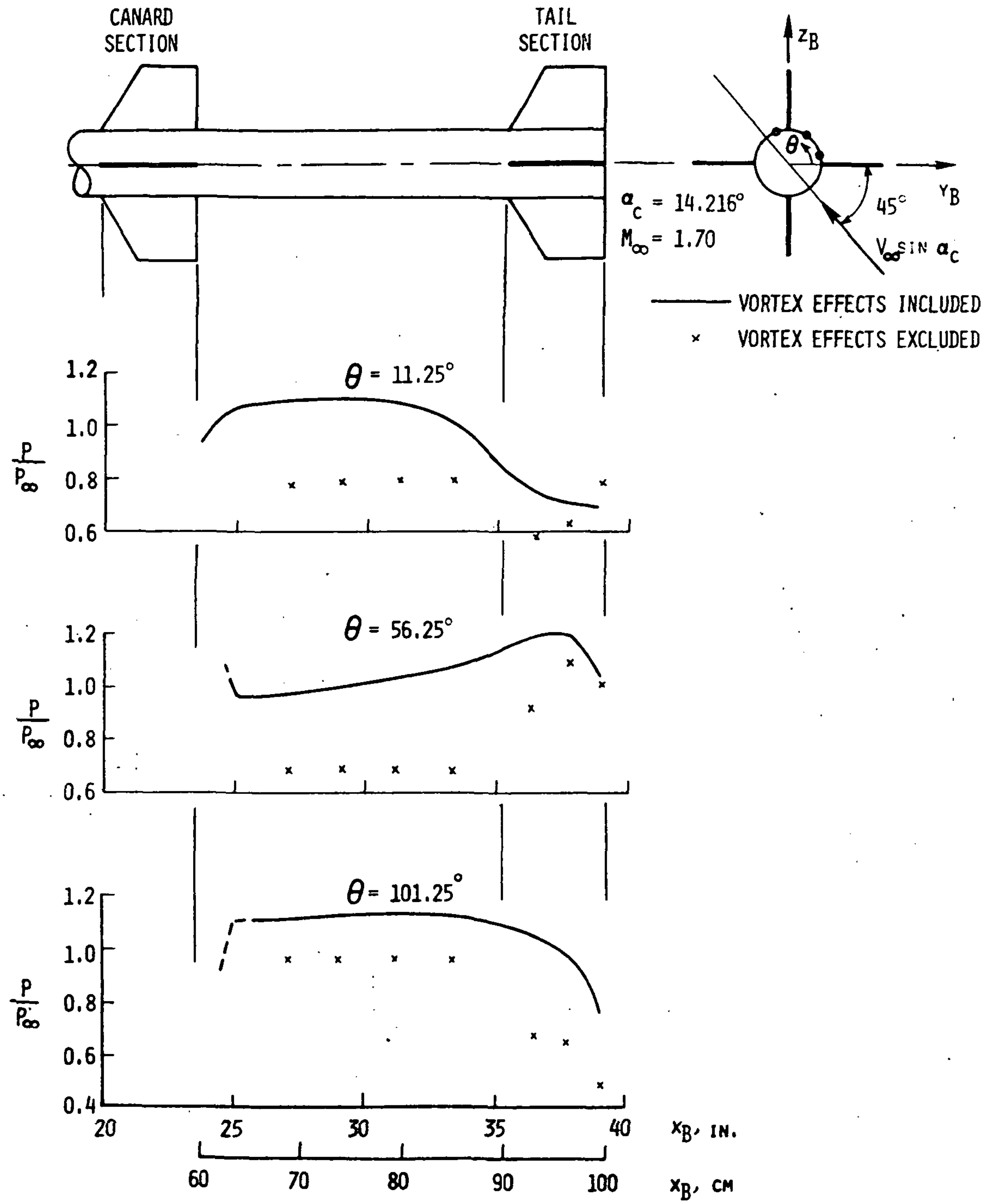


Figure 19.- Calculated pressure distributions along body meridians from canard section to body base, first sample case, step 6.

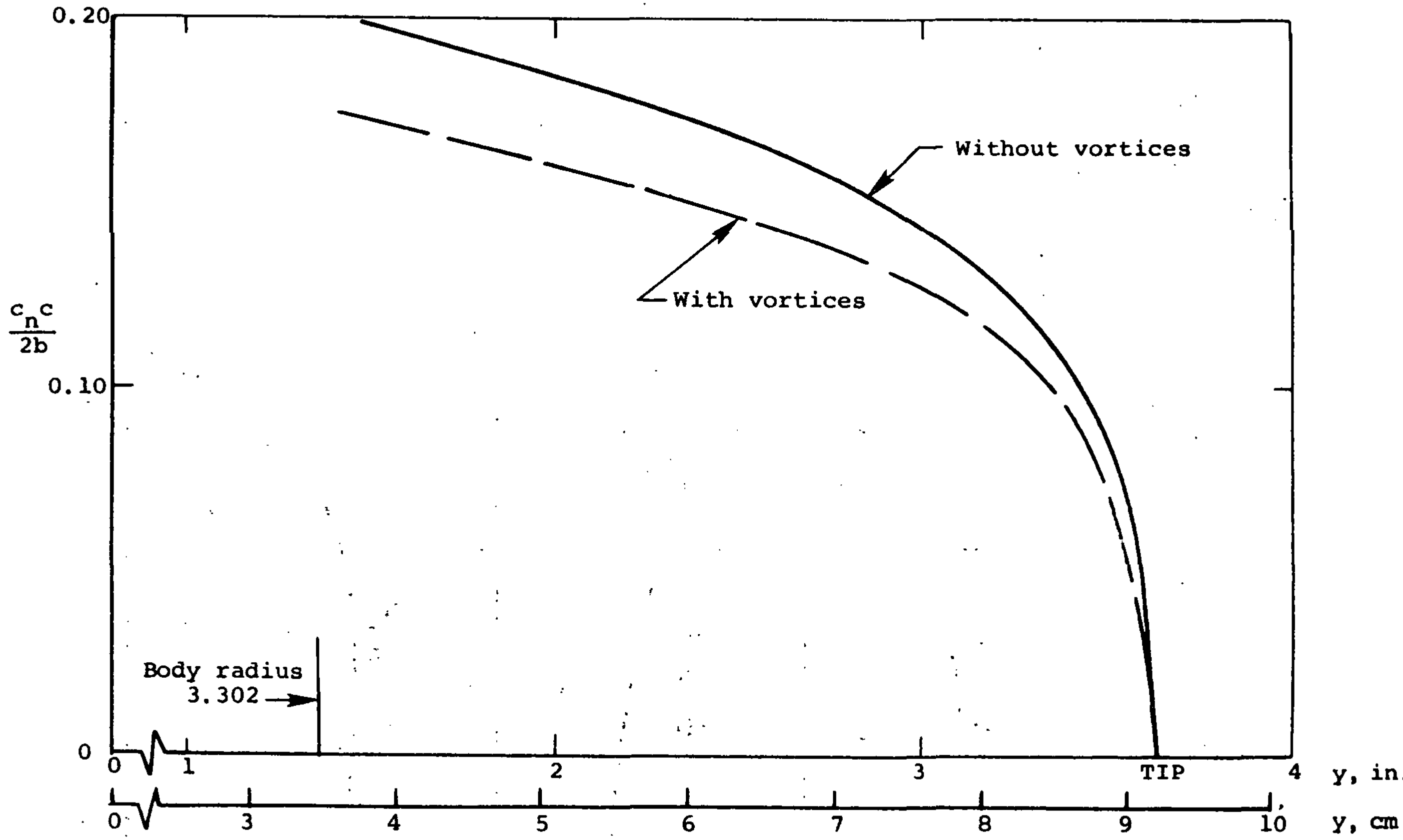


Figure 20.- Calculated span load distribution on right horizontal tail fin, first sample case, step 6.

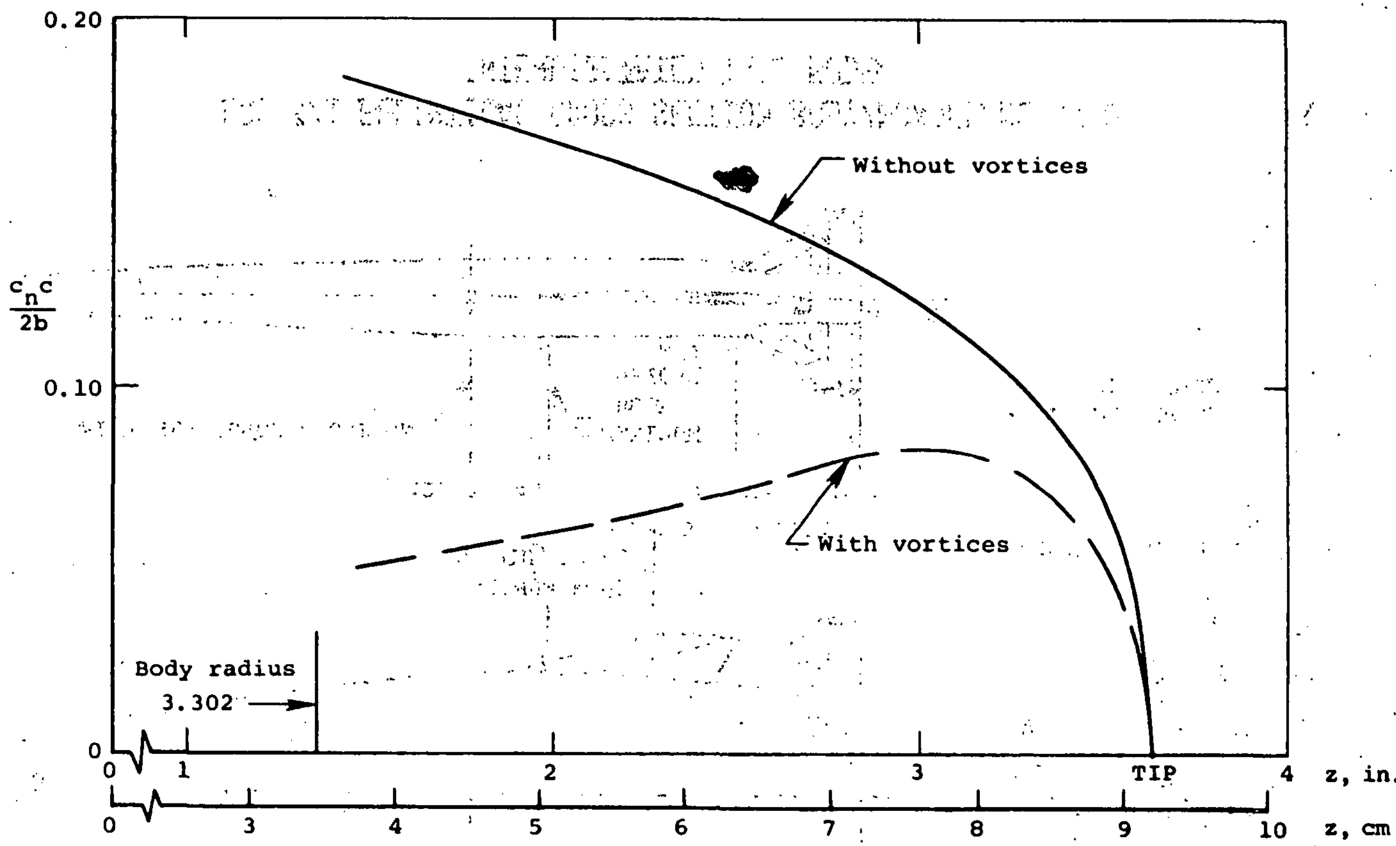
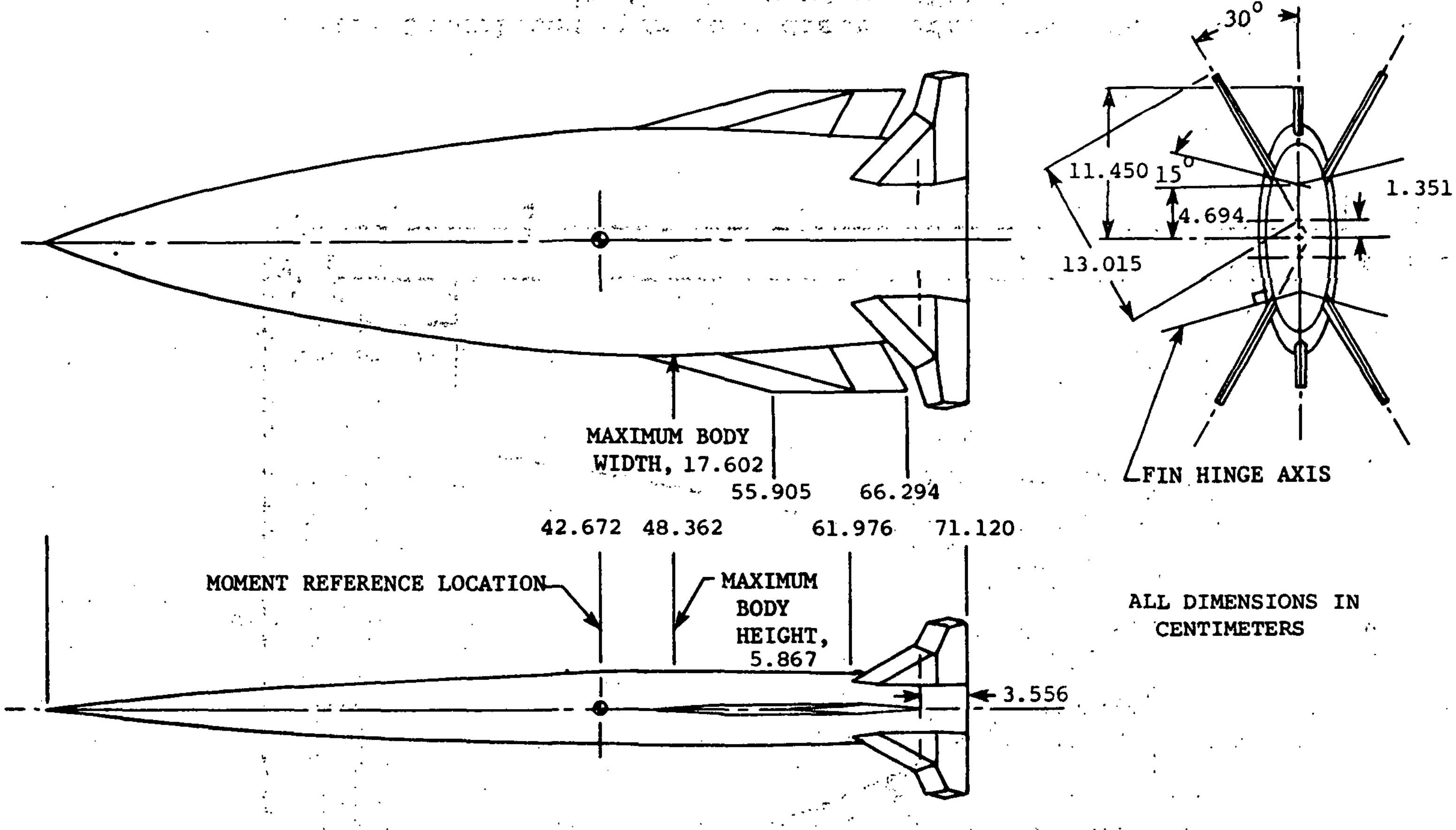


Figure 21.- Calculated span-load distribution on upper vertical fin, first sample case, step 6.



LRC 3/1 ELLIPTICAL CROSS SECTION BODY/MONOPLANE WING/ INTERDIGITATED TAIL MODEL

Figure 22.- Configuration used for second sample case.

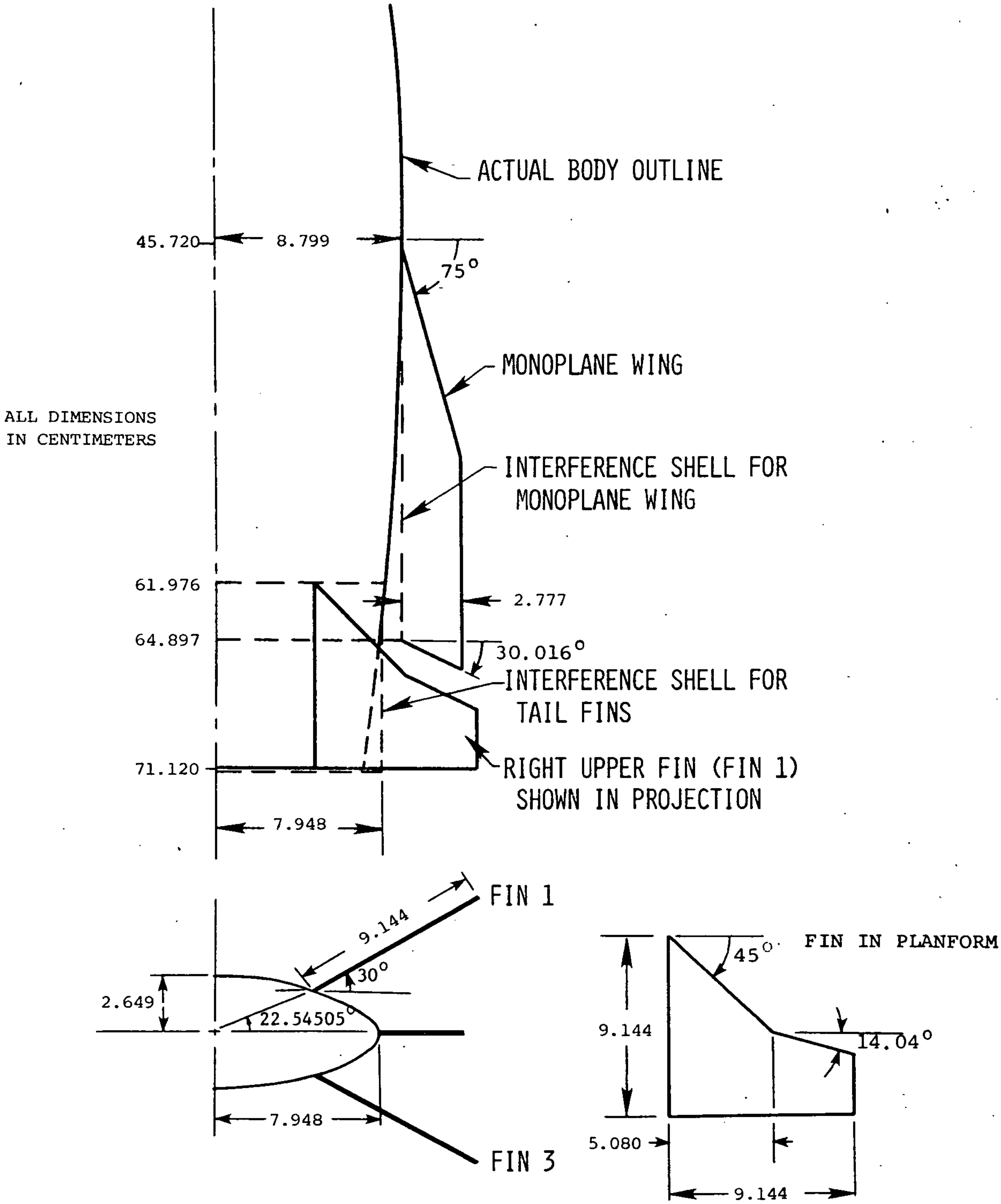
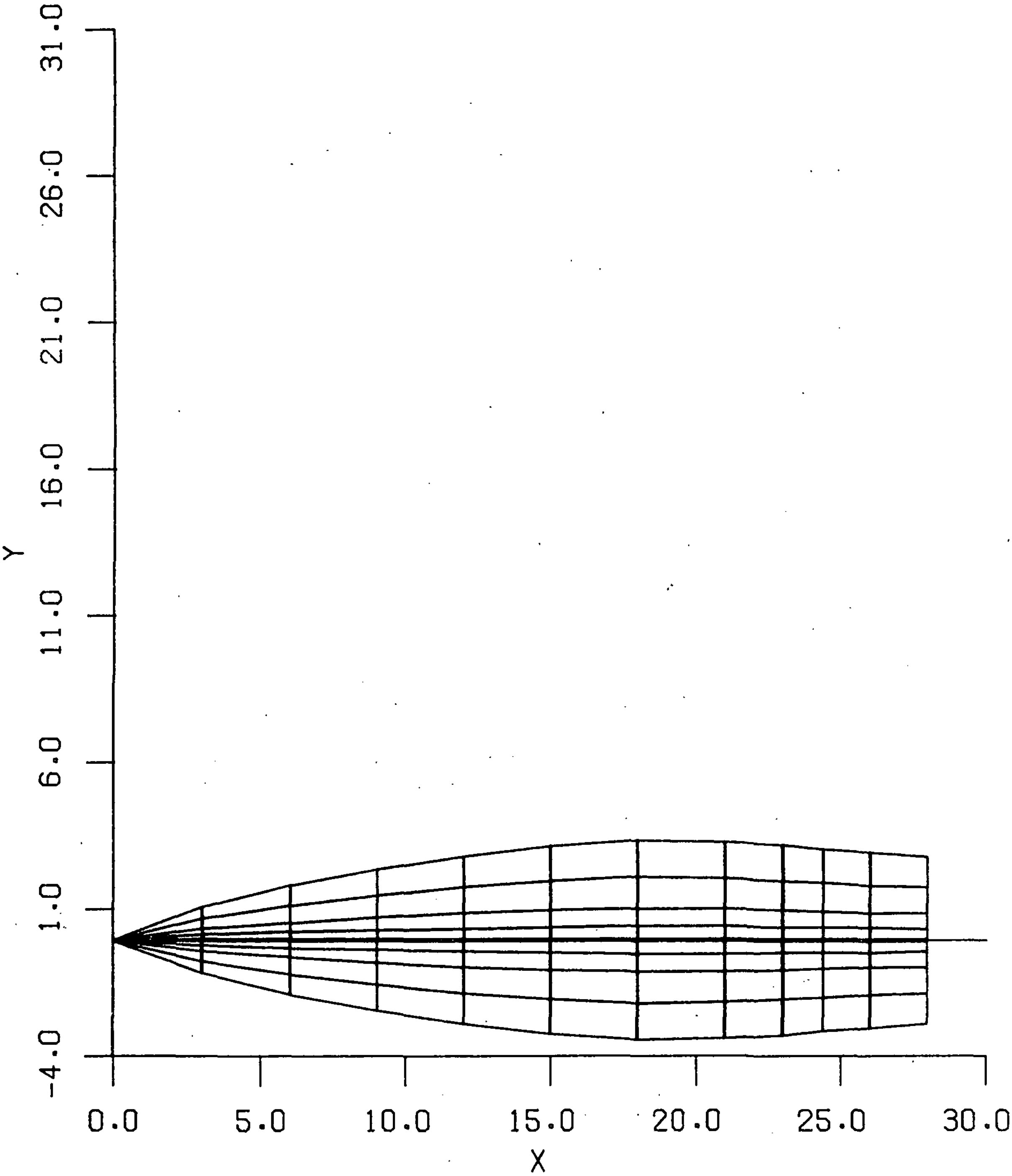
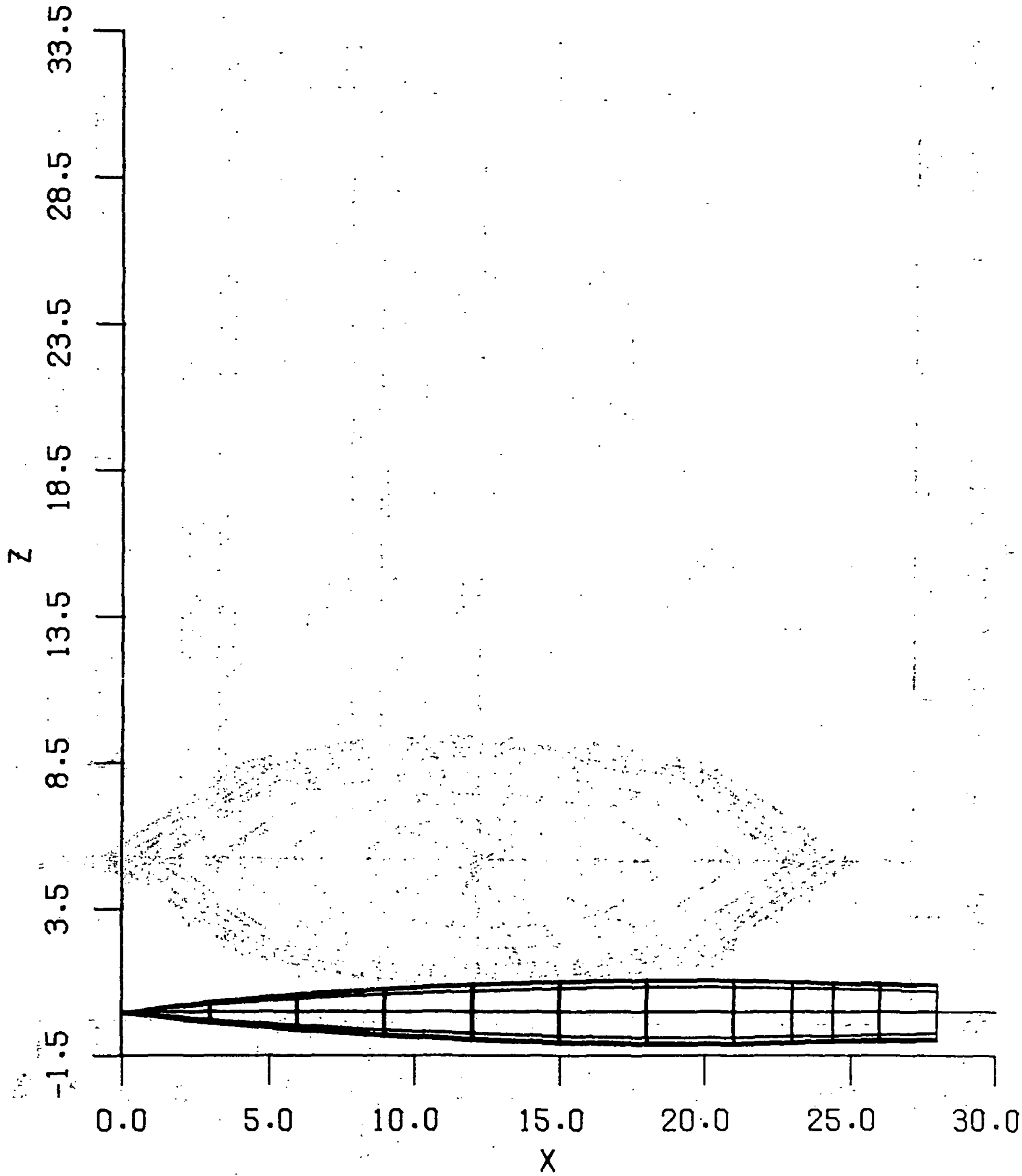


Figure 23.- Geometrical details, idealizations of configuration used for second sample case.



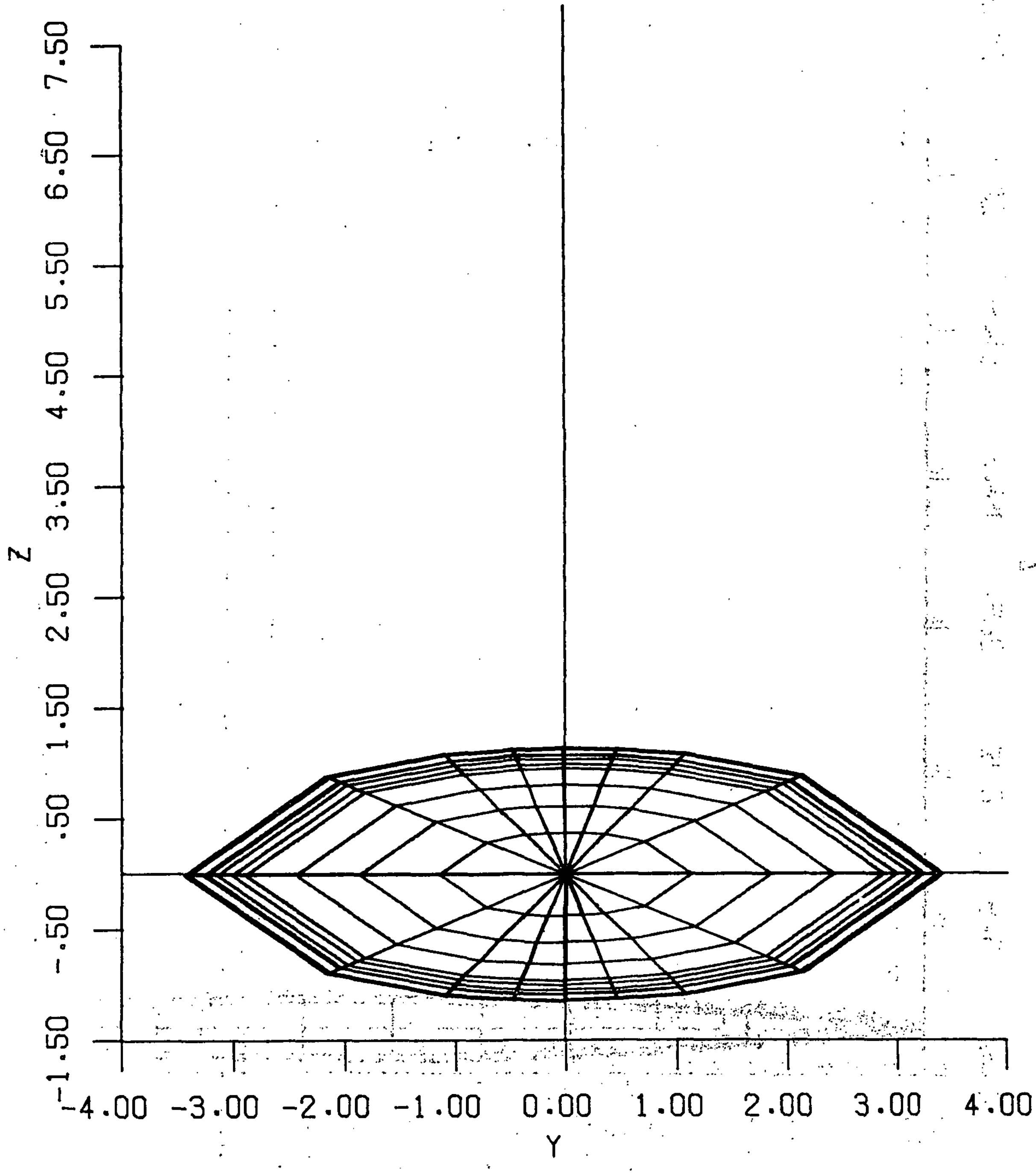
(a) Plan View

Figure 24.- Body source paneling layout, second sample case.



(b) Elevation

Figure 24.- Continued.



(c) End View

Figure 24.- Concluded.

```
 LRC 3/1 ELLIPTIC WING/BODY MISSILE CONFIGURATION - NOSE VORTICITY
  1   0   0   0   0   0   0   0   0   0 22   2 10   0                                          IPRT
18.0   0.0                                                                                      XWLE
  0   0 -3   0   0   0 -1   0   0   1 13 30   0   0   0   0   0   0   0   0   0   0  0JCARD
  0.000    .420    .700   2.100   3.500   4.900   5.600   6.300   7.700   8.400   XFUS
  9.100  10.500  11.900  12.600  13.300  14.700  15.400  16.800  17.500  18.200   XFUS
 19.040  19.600  20.300  21.000  22.400  23.100  24.500  25.900  26.600  28.000   XFUS
 0.0000   .2675   .3914   .8808  1.2745  1.6168  1.7736  1.9222  2.1978  2.3256   FUSBY
 2.4471  2.6721  2.8735  2.9653  3.0510  3.2033  3.2692  3.3777  3.4184  3.4481   FUSBY
 3.4641  3.4563  3.4322  3.3970  3.3029  3.2476  3.1283  3.0090  2.9552  2.8846   FUSBY
 0.0000   .0892   .1305   .2936   .4248   .5389   .5912   .6407   .7326   .7752   FUSAZ
  .8157   .8907   .9578   .9884  1.0170  1.0678  1.0897  1.1259  1.1395  1.1494   FUSAZ
 1.1547  1.1521  1.1441  1.1323  1.1010  1.0825  1.0428  1.0030   .9851   .9615   FUSAZ
ELLIPTIC BODY PANELING -     KRAD=9, KFORX=11
  0   0 -2                                                                        BC/PRINT
  1   0   1   0   0   0 -1   0   0   1   9 11   0   0   0   0   0   0            KCARD
12.567                   3.4641             16.8                                  REF
0.0      2.0      4.0      6.0      8.0      10.      12.      14.      16.      18.       XV
0.000    3.000    6.000    9.000    12.00    15.00    18.00    21.00    23.00    24.40     XFUS10
25.6                                                                              XFUS11
1.70     10.                                                                      MALPHA
0.0      .653     .990     1.281    1.528    1.7465  1.932    2.1      2.24     2.35      YVRTX1
 0.0     .299     .531     .739     .929     1.1028  1.272    1.423    1.551    1.673     ZVRTX1
 0.0      .191     .4725    .675     .851     1.008   1.151    1.283    1.406    1.52     GAM1
0.0      -.653    -.990    -1.281   -1.528   -1.7465-1.932   -2.1     -2.24    -2.35      YVRTX2
 0.0     .299     .531     .739     .929     1.1028  1.272    1.423    1.551    1.673     ZVRTX2
 0.0     -.191    -.4725   -.675    -.851    -1.008  -1.151   -1.283   -1.406   -1.52     GAM2
-1.0
```

Figure 25.- Input of program WDYBDY, second sample case, step 2.

```
WOODWARD'S SOURCE PANEL BODY MODELING PROGRAM          DATED JUNE, 1977

              LIST OF INPUT CARDS

LRC 3/1 ELLIPTIC WING/BODY MISSILE CONFIGURATION - NOSE VORTICITY
 1  0  0  0  0  0  0  0  0  0 22  2 10  0                                     IPRT
18.0  0.0                                                                     XWLE
 0  0 -3  0  0  0 -1  0  0  1 13 30  0  0  0  0  0  0  0  0  0  0  0         0JCARD
 0.000   .420   .700  2.100  3.500  4.900  5.600  6.300  7.700  8.400         XFUS
 9.100 10.500 11.900 12.600 13.300 14.700 15.400 16.800 17.500 18.200         XFUS
19.040 19.600 20.300 21.000 22.400 23.100 24.500 25.900 26.600 28.000         XFUS
0.0000  .2675  .3914  .8808 1.2745 1.6168 1.7736 1.9222 2.1978 2.3256         FUSBY
2.4471 2.6721 2.8735 2.9653 3.0510 3.2033 3.2692 3.3777 3.4184 3.4481         FUSBY
3.4641 3.4563 3.4322 3.3970 3.3029 3.2476 3.1283 3.0090 2.9552 2.8846         FUSBY
0.0000  .0892  .1305  .2936  .4248  .5389  .5912  .6407  .7326  .7752         FUSAZ
 .8157  .8907  .9578  .9884 1.0170 1.0678 1.0897 1.1259 1.1395 1.1494         FUSAZ
1.1547 1.1521 1.1441 1.1323 1.1010 1.0825 1.0428 1.0030  .9851  .9615         FUSAZ
ELLIPTIC BODY PANELING -    KRAD=9, KFORX=11
 0  0 -2                                                                      BC/PRINT
 1  0  1  0  0  0 -1  0  0  1  9 11  0  0  0  0  0  0                         KCARD
12.567              3.4641             16.8                                   REF
0.0     2.0     4.0     6.0     8.0     10.     12.     14.     16.     18.   XV
0.000   3.000   6.000   9.000   12.00   15.00   18.00   21.00   23.00   24.40 XFUS10
25.6                                                                          XFUS11
1.70    10.                                                                   MALPHA
0.0     .653    .990    1.281   1.528   1.7465 1.932  2.1     2.24    2.35    YVRTX1
 0.0    .299    .531    .739    .929    1.1028 1.272  1.423   1.551   1.673   ZVRTX1
 0.0     .191    .4725   .675    .851    1.008  1.151  1.283   1.406  1.52    GAM1
0.0     -.653   -.990   -1.281  -1.528  -1.7465-1.932 -2.1    -2.24   -2.35   YVRTX2
 0.0    .299    .531    .739    .929    1.1028 1.272  1.423   1.551   1.673   ZVRTX2
 0.0    -.191   -.4725  -.675   -.851   -1.008 -1.151 -1.283  -1.406  -1.52   GAM2
-1.0


              BEGIN A NEW CONFIGURATION                                                      ** WDYBDY **


   LRC 3/1 ELLIPTIC WING/BODY MISSILE CONFIGURATION - NOSE VORTICITY                         ** GEOM   **


   ADDITIONAL PRINT OPTIONS (IPRT) + XZ-PANEL SYMMETRY
   TV   GEOM VORTEX    VEL   SOLN  IXZSYM
   1      0     0       0      0     0

   PLOT OPTIONS (IPLOT)
 GEOM     CP  U/V/W
   0      0     0       0
```

Figure 26.- Output of program WDYBDY, second sample case, step 2.

```
    VORTEX CALCULATION CONTROL
 N-CPT   NVTX  NXVTX NCPOUT  NVLIN
   22      2     10      0      0

    X-LE     XSTART
  18.000     0.000

        J-DATA CARDS REQUIRED (NO=0,YES.NE.0)

  REFA     WING    BODY      POD   V.FIN H.TAIL YY-SYM
   J0       J1      J2        J3     J4     J5     J6
   0        0       -3        0      0      0      -1

 WING GEOM:   NWAF=     0   NWAFOR=    0
 BODY GEOM:   NFUS=     1    NRADX=   13     0     0     0
                             NFORX=   30     0     0     0
  POD GEOM:     NP=     0   NPODOR=    0
V.FIN GEOM:     NF=     0   NFINOR=    0
H.TAIL GEOM:  NCAN=     0   NCANOR=    0


        VEHICLE GEOMETRY DEFINITION                                                                                     ** CONFIG **
    REFERENCE AREA (J0.GT.0)     REFA=  1.00000

 NFU      XFUS - FUSELAGE X-STATIONS
  1     0.0000     .4200     .7000    2.1000    3.5000    4.9000    5.6000    6.3000    7.7000    8.4000
  1     9.1000   10.5000   11.9000   12.6000   13.3000   14.7000   15.4000   16.8000   17.5000   18.2000
  1    19.0400   19.6000   20.3000   21.0000   22.4000   23.1000   24.5000   25.9000   26.6000   28.0000

 NFU      FUSRY - ELLIPTIC FUSELAGE SEMI-MAJOR AXES
  1     0.0000     .2675     .3914     .8808    1.2745    1.6168    1.7736    1.9222    2.1978    2.3256
  1     2.4071    2.6721    2.8735    2.9653    3.0510    3.2033    3.2692    3.3777    3.4184    3.4481
  1     3.4641    3.4563    3.4322    3.3970    3.3029    3.2476    3.1283    3.0090    2.9552    2.8846

 NFU      FUSAZ - ELLIPTIC FUSELAGE SEMI-MINOR AXES
  1     0.0000     .0892     .1305     .2936     .4248     .5389     .5912     .6407     .7326     .7752
  1      .8157     .8907     .9578     .9884    1.0170    1.0678    1.0897    1.1259    1.1395    1.1494
  1     1.1547    1.1521    1.1441    1.1323    1.1010    1.0825    1.0428    1.0030     .9851     .9615


    ELLIPTIC BODY PANELING -     KRAD=9, KFORX=11                                                                      ** GEOM   **

 LINBC  THICK IPRINT   LCPA   LCPB   LCPC  ITMAX CCTEST
   0      0     -2      0      0      0      0   0.00000
```

Figure 26.- Continued.

K-DATA CARDS, ADDITIONAL CARDS FOR PANELING

REF	WING	BODY	N/A	V.FIN	H.TAIL	N/A
K0	K1	K2	K3	K4	K5	K6
1	0	1	0	0	0	-1

WING PANEL:	K-AF=	0	KWAFOR=	0			
BODY PANEL:	KFUS=	1	KRADX=	9	0	0	0
			KFORX=	11	0	0	0

PANEL REFERENCE LENGTHS

REFAR	REFB	REFC	REFD	REFL	REFX	REFZ
12.567	0.000	0.000	3.464	0.000	16.800	0.000

VORTEX LOCATIONS AND BODY AXES ** READVX **

XV=	0.0000	2.0000	4.0000	6.0000	8.0000	10.0000	12.0000	14.0000	16.0000	18.0000
BY=	0.0000	.8458	1.3968	1.8585	2.2526	2.5917	2.8866	3.1272	3.3157	3.4396
AZ=	0.0000	.2820	.4656	.6195	.7509	.8639	.9622	1.0424	1.1052	1.1466

BODY PANEL CORNER POINT COORDINATES ** BODPAN **

1 AND 3 INDICATE BODY PANEL LEADING-EDGE POINTS, 2 AND 4 INDICATE TRAILING-EDGE POINTS

PANEL	X 1	Y 1	Z 1	X 2	Y 2	Z 2	X 3	Y 3	Z 3	X 4	Y 4	Z 4
1	0.00000	0.00000	0.00000	3.00000	.00000	-.37794	0.00000	0.00000	0.00000	3.00000	.15508	-.37439
2	0.00000	0.00000	0.00000	3.00000	.15508	-.37439	0.00000	0.00000	0.00000	3.00000	.35855	-.35855
3	0.00000	0.00000	0.00000	3.00000	.35855	-.35855	0.00000	0.00000	0.00000	3.00000	.71086	-.29445
4	0.00000	0.00000	0.00000	3.00000	.71086	-.29445	0.00000	0.00000	0.00000	3.00000	.13389	.00000
5	0.00000	0.00000	0.00000	3.00000	1.13389	.00000	0.00000	0.00000	0.00000	3.00000	.71086	.29445
6	0.00000	0.00000	0.00000	3.00000	.71086	.29445	0.00000	0.00000	0.00000	3.00000	.35855	.35855
7	0.00000	0.00000	0.00000	3.00000	.35855	.35855	0.00000	0.00000	0.00000	3.00000	.15508	.37439
8	0.00000	0.00000	0.00000	3.00000	.15508	.37439	0.00000	0.00000	0.00000	3.00000	.00000	.37794
9	3.00000	.00000	-.37794	6.00000	.00000	-.61949	3.00000	.15508	-.37439	6.00000	.25419	-.61366
10	3.00000	.15508	-.37439	6.00000	.25419	-.61366	3.00000	.35855	-.35855	6.00000	.58770	-.58770
11	3.00000	.35855	-.35855	6.00000	.58770	-.58770	3.00000	.71086	-.29445	6.00000	1.16516	-.48263
12	3.00000	.71086	-.29445	6.00000	1.16516	-.48263	3.00000	1.13389	.00000	6.00000	1.85851	.00000
13	3.00000	1.13389	.00000	6.00000	1.85851	.00000	3.00000	.71086	.29445	6.00000	1.16516	.48263
14	3.00000	.71086	.29445	6.00000	1.16516	.48263	3.00000	.35855	.35855	6.00000	.58770	.58770
15	3.00000	.35855	.35855	6.00000	.58770	.58770	3.00000	.15508	.37439	6.00000	.25419	.61366
16	3.00000	.15508	.37439	6.00000	.25419	.61366	3.00000	-.00000	.37794	6.00000	-.00000	.61949
17	6.00000	.00000	-.61949	9.00000	.00000	-.80991	6.00000	.25419	-.61366	9.00000	.33232	-.80230
18	6.00000	.25419	-.61366	9.00000	.33232	-.80230	6.00000	.58770	-.58770	9.00000	.76835	-.76835
19	6.00000	.58770	-.58770	9.00000	.76835	-.76835	6.00000	1.16516	-.48263	9.00000	1.52331	-.63098
20	6.00000	1.16516	-.48263	9.00000	1.52331	-.63098	6.00000	1.85851	.00000	9.00000	2.42974	.00000

Figure 26.- Continued.

21	6.00000	1.85851	.00000	9.00000	2.42970	.00000	6.00000	1.16516	.48263	9.00000	1.52331	.63098
22	6.00000	1.16516	.48263	9.00000	1.52331	.63098	6.00000	.58770	.58770	9.00000	.76835	.76835
23	6.00000	.58770	.58770	9.00000	.76835	.76835	6.00000	.25419	.61366	9.00000	.33232	.80230
24	6.00000	.25419	.61366	9.00000	.33232	.80230	6.00000	-.00000	.61949	9.00000	-.00000	.80991
25	9.00000	.00000	-.80991	12.00000	.00000	-.96217	9.00000	.33232	-.80230	12.00000	.39480	-.95313
26	9.00000	.33232	-.80230	12.00000	.39480	-.95313	9.00000	.76835	-.76835	12.00000	.91280	-.91280
27	9.00000	.76835	-.76835	12.00000	.91280	-.91280	9.00000	1.52331	-.63098	12.00000	1.80970	-.74960
28	9.00000	1.52331	-.63098	12.00000	1.80970	-.74960	9.00000	2.42974	.00000	12.00000	2.88661	.00000
29	9.00000	2.42974	.00000	12.00000	2.88661	.00000	9.00000	1.52331	.63098	12.00000	1.80970	.74960
30	9.00000	1.52331	.63098	12.00000	1.80970	.74960	9.00000	.76835	.76835	12.00000	.91280	.91280
31	9.00000	.76835	.76835	12.00000	.91280	.91280	9.00000	.33232	.80230	12.00000	.39480	.95313
32	9.00000	.33232	.80230	12.00000	.39480	.95313	9.00000	-.00000	.80991	12.00000	-.00000	.96217
33	12.00000	.00000	-.96217	15.00000	.00000	-1.07719	12.00000	.39480	-.95313	15.00000	.44199	-1.06706
34	12.00000	.39480	-.95313	15.00000	.44199	-1.06706	12.00000	.91280	-.91280	15.00000	1.02191	-1.02191
35	12.00000	.91280	-.91280	15.00000	1.02191	-1.02191	12.00000	1.80970	-.74960	15.00000	2.02600	-.83920
36	12.00000	1.80970	-.74960	15.00000	2.02600	-.83920	12.00000	2.88661	.00000	15.00000	3.23154	.00000
37	12.00000	2.88661	.00000	15.00000	3.23154	.00000	12.00000	1.80970	.74960	15.00000	2.02600	.83920
38	12.00000	1.80970	.74960	15.00000	2.02600	.83920	12.00000	.91280	.91280	15.00000	1.02191	1.02191
39	12.00000	.91280	.91280	15.00000	1.02191	1.02191	12.00000	.39480	.95313	15.00000	.44199	1.06706
40	12.00000	.39480	.95313	15.00000	.44199	1.06706	12.00000	-.00000	.96217	15.00000	-.00000	1.07719
41	15.00000	.00000	-1.07719	18.00000	.00000	-1.14657	15.00000	.44199	-1.06706	18.00000	.47046	-1.13580
42	15.00000	.44199	-1.06706	18.00000	.47046	-1.13580	15.00000	1.02191	-1.02191	18.00000	1.08773	-1.08773
43	15.00000	1.02191	-1.02191	18.00000	1.08773	-1.08773	15.00000	2.02600	-.83920	18.00000	2.15648	-.89324
44	15.00000	2.02600	-.83920	18.00000	2.15648	-.89324	15.00000	3.23154	.00000	18.00000	3.43961	.00000
45	15.00000	3.23154	.00000	18.00000	3.43961	.00000	15.00000	2.02600	.83920	18.00000	2.15648	.89324
46	15.00000	2.02600	.83920	18.00000	2.15648	.89324	15.00000	1.02191	1.02191	18.00000	1.08773	1.08773
47	15.00000	1.02191	1.02191	18.00000	1.08773	1.08773	15.00000	.44199	1.06706	18.00000	.47046	1.13580
48	15.00000	.44199	1.06706	18.00000	.47046	1.13580	15.00000	-.00000	1.07719	18.00000	-.00000	1.14657
49	18.00000	.00000	-1.14657	21.00000	.00000	-1.13230	18.00000	.47046	-1.13580	21.00000	.46461	-1.12166
50	18.00000	.47046	-1.13580	21.00000	.46461	-1.12166	18.00000	1.08773	-1.08773	21.00000	1.07420	-1.07420
51	18.00000	1.08773	-1.08773	21.00000	1.07420	-1.07420	18.00000	2.15648	-.89324	21.00000	2.12969	-.88215
52	18.00000	2.15648	-.89324	21.00000	2.12969	-.88215	18.00000	3.43961	.00000	21.00000	3.39700	.00000
53	18.00000	3.43961	.00000	21.00000	3.39700	.00000	18.00000	2.15648	.89324	21.00000	2.12969	.88215
54	18.00000	2.15648	.89324	21.00000	2.12969	.88215	18.00000	1.08773	1.08773	21.00000	1.07420	1.07420
55	18.00000	1.08773	1.08773	21.00000	1.07420	1.07420	18.00000	.47046	1.13580	21.00000	.46461	1.12166
56	18.00000	.47046	1.13580	21.00000	.46461	1.12166	18.00000	-.00000	1.14657	21.00000	-.00000	1.13230
57	21.00000	.00000	-1.13230	23.00000	.00000	-1.08514	21.00000	.46461	-1.12166	23.00000	.44526	-1.07495
58	21.00000	.46461	-1.12166	23.00000	.44526	-1.07495	21.00000	1.07420	-1.07420	23.00000	1.02946	-1.02946
59	21.00000	1.07420	-1.07420	23.00000	1.02946	-1.02946	21.00000	2.12969	-.88215	23.00000	2.04099	-.84540
60	21.00000	2.12969	-.88215	23.00000	2.04099	-.84540	21.00000	3.39700	.00000	23.00000	3.25550	.00000
61	21.00000	3.39700	.00000	23.00000	3.25550	.00000	21.00000	2.12969	.88215	23.00000	2.04099	.84540
62	21.00000	2.12969	.88215	23.00000	2.04099	.84540	21.00000	1.07420	1.07420	23.00000	1.02946	1.02946
63	21.00000	1.07420	1.07420	23.00000	1.02946	1.02946	21.00000	.46461	1.12166	23.00000	.44526	1.07495
64	21.00000	.46461	1.12166	23.00000	.44526	1.07495	21.00000	-.00000	1.13230	23.00000	-.00000	1.08514
65	23.00000	.00000	-1.08514	24.40000	.00000	-1.04564	23.00000	.44526	-1.07495	24.40000	.42905	-1.03581
66	23.00000	.44526	-1.07495	24.40000	.42905	-1.03581	23.00000	1.02946	-1.02946	24.40000	.99197	-.99197
67	23.00000	1.02946	-1.02946	24.40000	.99197	-.99197	23.00000	2.04099	-.84540	24.40000	1.96664	-.81461
68	23.00000	2.04099	-.84540	24.40000	1.96664	-.81461	23.00000	3.25550	.00000	24.40000	3.13682	.00000
69	23.00000	3.25550	.00000	24.40000	3.13682	.00000	23.00000	2.04099	.84540	24.40000	1.96664	.81461
70	23.00000	2.04099	.84540	24.40000	1.96664	.81461	23.00000	1.02946	1.02946	24.40000	.99197	.99197
71	23.00000	1.02946	1.02946	24.40000	.99197	.99197	23.00000	.44526	1.07495	24.40000	.42905	1.03581
72	23.00000	.44526	1.07495	24.40000	.42905	1.03581	23.00000	-.00000	1.08514	24.40000	-.00000	1.04564

Figure 26.- Continued.

73	24.40000	.00000	-1.04564	25.60000	.00000	-1.01153	24.40000	.42905	-1.03581	25.60000	.41505	-1.00202
74	24.40000	.42905	-1.03581	25.60000	.41505	-1.00202	24.40000	.99197	-.99197	25.60000	.95962	-.95962
75	24.40000	.99197	-.99197	25.60000	.95962	-.95962	24.40000	1.96664	-.81461	25.60000	1.90251	-.78804
76	24.40000	1.96664	-.81461	25.60000	1.90251	-.78804	24.40000	3.13682	.00000	25.60000	3.03456	.00000
77	24.40000	3.13682	.00000	25.60000	3.03456	.00000	24.40000	1.96664	.81461	25.60000	1.90251	.78804
78	24.40000	1.96644	.81461	25.60000	1.90251	.78804	24.40000	.99197	.99197	25.60000	.95962	.95962
79	24.40000	.99197	.99197	25.60000	.95962	.95962	24.40000	.42905	1.03981	25.60000	.41505	1.00202
80	24.40000	.42905	1.03581	25.60000	.41505	1.00202	24.40000	-.00000	1.04564	25.60000	-.00000	1.01153

BODY PANEL CENTROID POINT COORDINATES

POINT	X CP	Y CP	Z CP
1	2.00000	.05169	-.25078
2	2.00000	.17121	-.24431
3	2.00000	.35447	-.21767
4	2.00000	.61492	-.09815
5	2.00000	.61492	.09815
6	2.00000	.35447	.21767
7	2.00000	.17121	.24431
8	2.00000	.05169	.25076
9	4.62108	.10432	-.50607
10	4.62108	.34550	-.49303
11	4.62108	.71936	-.43925
12	4.62107	1.24090	-.19807
13	4.62107	1.24090	.19807
14	4.62108	.71936	.43925
15	4.62108	.34550	.49303
16	4.62108	.10432	.50607
17	7.56661	.14750	-.71555
18	7.56661	.48851	-.69710
19	7.56661	1.01711	-.62107
20	7.56660	1.75450	-.28005
21	7.56660	1.75450	.28005
22	7.56661	1.01711	.62107
23	7.56661	.48851	.69710
24	7.56661	.14750	.71555
25	10.54296	.18223	-.88405
26	10.54296	.60355	-.86126
27	10.54297	1.25463	-.76732
28	10.54297	2.16767	-.34599
29	10.54297	2.16767	.34599
30	10.54297	1.25463	.76732
31	10.54296	.60355	.86126
32	10.54296	.18223	.88405
33	13.52820	.20942	-1.01596
34	13.52820	.69361	-.98977
35	13.52819	1.44413	-.88181
36	13.52818	2.49110	-.39762
37	13.52818	2.49110	.39762
38	13.52819	1.44413	.88181
39	13.52820	.69361	.98977
40	13.52820	.20942	1.01596

Figure 26.- Continued.

41	16.51560	.22819	-1.10701
42	16.51560	.75577	-1.07847
43	16.51560	1.57354	-.96083
44	16.51559	2.71429	-.43325
45	16.51559	2.71429	.43325
46	16.51560	1.57354	.96083
47	16.51560	.75577	1.07847
48	16.51560	.22819	1.10701
49	19.49687	.23377	-1.13410
50	19.49687	.77426	-1.10486
51	19.49688	1.61204	-.98434
52	19.49689	2.78073	-.44385
53	19.49689	2.78073	.44385
54	19.49688	1.61204	.98434
55	19.49687	.77426	1.10486
56	19.49687	.23377	1.13410
57	21.99291	.22750	-1.10368
58	21.99291	.75349	-1.07523
59	21.99291	1.56882	-.95795
60	21.99291	2.70620	-.43195
61	21.99291	2.70620	.43195
62	21.99291	1.56882	.95795
63	21.99291	.75349	1.07523
64	21.99291	.22750	1.10368
65	23.69567	.21860	-1.06050
66	23.69567	.72402	-1.03317
67	23.69567	1.50744	-.92047
68	23.69567	2.60029	-.41505
69	23.69567	2.60029	.41505
70	23.69567	1.50744	.92047
71	23.69567	.72402	1.03317
72	23.69567	.21860	1.06050
73	24.99668	.21104	-1.02384
74	24.99668	.69899	-.99745
75	24.99669	1.45532	-.88864
76	24.99669	2.51036	-.40070
77	24.99669	2.51036	.40070
78	24.99669	1.45532	.88864
79	24.99668	.69899	.99745
80	24.99668	.21104	1.02384

BODY PANEL AREAS AND INCLINATION ANGLES

PANEL	AREA	DELTA RAD	THETA RAD	DELTA DEG	THETA DEG
1	.23452	.12529	-3.11870	7.17849	-178.688
2	.30865	.12773	-3.06389	7.31861	-175.548
3	.54231	.13810	-2.96162	7.91231	-169.688
4	.79094	.21266	-2.53353	12.18448	-145.160
5	.79094	.21266	-.60807	12.18448	-34.840
6	.54231	.13810	-.17998	7.91231	-10.312

Figure 26.- Continued.

7	.30865	.12773	-.07770	7.31861	-4.452
8	.23452	.12529	-.02290	7.17849	-1.312
9	.61605	.08032	-3.11870	4.60200	-178.688
10	.81063	.08190	-3.06389	4.69239	-175.548
11	1.42314	.08859	-2.96161	5.07577	-169.688
12	2.05964	.13713	-2.53351	7.85675	-145.160
13	2.05964	.13713	-.60808	7.85675	-34.840
14	1.42314	.08859	-.17998	5.07577	-10.312
15	.81063	.08190	-.07770	4.69239	-4.452
16	.61605	.08032	-.02290	4.60200	-1.312
17	.88177	.06337	-3.11869	3.63109	-178.688
18	1.16022	.06462	-3.06389	3.70252	-175.548
19	2.03642	.06991	-2.96160	4.00557	-169.687
20	2.94107	.10836	-2.53349	6.20859	-145.158
21	2.94107	.10836	-.60810	6.20859	-34.842
22	2.03642	.06991	-.17999	4.00557	-10.313
23	1.16022	.06462	-.07771	3.70252	-4.452
24	.88177	.06337	-.02290	3.63109	-1.312
25	1.09238	.05070	-3.11869	2.90465	-178.688
26	1.43729	.05169	-3.06389	2.96189	-175.548
27	2.52243	.05593	-2.96160	3.20478	-169.687
28	3.63850	.08678	-2.53350	4.97216	-145.159
29	3.63850	.08678	-.60810	4.97216	-34.841
30	2.52243	.05593	-.17999	3.20478	-10.313
31	1.43729	.05169	-.07770	2.96189	-4.452
32	1.09238	.05070	-.02290	2.90465	-1.312
33	1.25644	.03831	-3.11869	2.19495	-178.688
34	1.65312	.03906	-3.06389	2.23818	-175.548
35	2.90091	.04227	-2.96160	2.42164	-169.687
36	4.18047	.06560	-2.53349	3.75857	-145.158
37	4.18047	.06560	-.60810	3.75857	-34.842
38	2.90091	.04227	-.17999	2.42164	-10.313
39	1.65312	.03906	-.07771	2.23818	-4.452
40	1.25644	.03831	-.02290	2.19495	-1.312
41	1.36941	.02312	-3.11869	1.32458	-178.688
42	1.80171	.02357	-3.06386	1.35068	-175.548
43	3.16135	.02551	-2.96159	1.46147	-169.687
44	4.55203	.03961	-2.53347	2.26947	-145.157
45	4.55203	.03961	-.60812	2.26947	-34.843
46	3.16135	.02551	-.18000	1.46146	-10.313
47	1.80171	.02357	-.07771	1.35068	-4.452
48	1.36941	.02312	-.02290	1.32458	-1.312
49	1.40299	-.00476	-3.11869	-.27248	-178.688
50	1.84548	-.00485	-3.06389	-.27779	-175.548
51	3.25873	-.00524	-2.96160	-.30034	-169.687
52	4.66146	-.00813	-2.53348	-.46563	-145.158
53	4.66146	-.00813	-.60811	-.46563	-34.842
54	3.25873	-.00524	-.18000	-.30034	-10.313
55	1.84588	-.00485	-.07771	-.27779	-4.452
56	1.40299	-.00476	-.02290	-.27248	-1.312
57	.91036	-.02357	-3.11869	-1.35035	-178.688
58	1.19775	-.02403	-3.06389	-1.37700	-175.548

Figure 26.- Continued.

```
59      2.10167    -.02601   -2.96161   -1.49009   -169.687
60      3.02636    -.04040   -2.55350   -2.31449   -145.159
61      3.02636    -.04040    -.60809   -2.31449    -34.841
62      2.10167    -.02601    -.17999   -1.49009    -10.313
63      1.19775    -.02403    -.07770   -1.37700     -4.452
64       .91036    -.02357    -.02290   -1.35035     -1.312
65       .61242    -.02829   -3.11869   -1.61602   -178.688
66       .80576    -.02876   -3.06389   -1.64800   -175.548
67      1.41385    -.03113   -2.96160   -1.78371   -169.687
68      2.03629    -.04837   -2.55348   -2.77161   -145.158
69      2.03629    -.04837    -.60811   -2.77161    -34.842
70      1.41385    -.03113    -.18000   -1.78371    -10.313
71       .80576    -.02876    -.07771   -1.64800     -4.452
72       .61242    -.02820    -.02290   -1.61602     -1.312
73       .50680    -.02841   -3.11869   -1.62762   -178.688
74       .66679    -.02897   -3.06388   -1.65967   -175.548
75      1.17000    -.03134   -2.96159   -1.79569   -169.687
76      1.68508    -.04866   -2.53347   -2.78778   -145.157
77      1.68508    -.04866    -.60812   -2.78778    -34.843
78      1.17000    -.03134    -.18000   -1.79569    -10.313
79       .66679    -.02897    -.07771   -1.65967     -4.452
80       .50680    -.02841    -.02290   -1.62762     -1.312


     END GEOM  ,  TIME=       .228       DT=       .228


          AERODYNAMIC VELCITY MATRIX COMPUTATION                                          ** VELCMP **


PARTITION =  1
NWINGS=     0   NBODYS=    80   NCPTS=     0   NSEGS=     0
INFLUENCE OF BODY ON BODY

        END BODVEL,  TIME=     5.3050      DT=     5.0770      NPART=  1
        NBBLOKS=    10  NWBLOKS=     1

        END VELCMP,  TIME=     5.3630      DT=     5.1350


                 BEGIN A NEW CASE                                                         ** NDYBDY **

        END DIAGIN,  TIME=     5.4350      DT=      .0650

THE ITERATION CONVERGED AFTER  11  ITERATIONS WITH A TEST CRITERION OF  .0010000

THE SOLUTION AT THE PREVIOUS ITERATION IS
 GR(N),N=1, 80
    .60815    .60675    .60245    .62066   -.24230   -.35677   -.37133   -.37538    .77418    .72887
    .70514    .73049   -.46254   -.54706   -.56437   -.59123    .67301    .67160    .74809    .77486
   -.55746   -.61343   -.56460   -.57469    .69438    .69136    .69179    .79600   -.61080   -.59570
```

Figure 26.- Continued.

-.60161	-.60523	.69517	.69731	.69166	.78268	-.64319	-.62337	-.63162	-.63179
.70879	.70667	.69999	.79237	-.70788	-.66863	-.67059	-.66967	.72405	.70972
.70103	.80192	-.83150	-.75263	-.75308	-.75563	.80566	.79111	.76535	.76222
-.89037	-.81893	-.81511	-.81820	.73959	.74769	.85206	.80431	-.90644	-.85580
-.79820	-.79912	.82312	.80987	.78823	.81892	-.94559	-.84463	-.85797	-.86823

THE SOLUTION AT THE PRESENT ITERATION IS
GR(N),N=1, 80

.60815	.60675	.60245	.62066	-.24230	-.35677	-.37133	-.37538	.77418	.72887
.70514	.73049	-.46254	-.54706	-.56037	-.59123	.67301	.67160	.74809	.77486
-.55746	-.61343	-.56960	-.57469	.69438	.69136	.69179	.79600	-.61080	-.59570
-.60161	-.60523	.69517	.69731	.69166	.78268	-.64319	-.62337	-.63162	-.63179
.70879	.70667	.69999	.79237	-.70788	-.66863	-.67059	-.66967	.72405	.70972
.70103	.80192	-.83150	-.75263	-.75308	-.75563	.80566	.79111	.76535	.76222
-.89037	-.81893	-.81511	-.81820	.73959	.74769	.85206	.80431	-.90644	-.85580
-.79820	-.79912	.82312	.80987	.78823	.81892	-.94559	-.84463	-.85797	-.86823

VORTEX LOCATION AND STRENGTH

** ELHOVT **

I= 1 YVRTX=	0.0000	.6530	.9900	1.2810	1.5280	1.7465	1.9320	2.1000	2.2400	2.3500
I= 1 ZVRTX=	0.0000	.2990	.5310	.7390	.9290	1.1028	1.2720	1.4230	1.5510	1.6730
I= 1 GX=	0.0000	.1910	.4725	.6750	.8510	1.0080	1.1510	1.2830	1.4060	1.5200
I= 2 YVRTX=	0.0000	-.6530	-.9900	-1.2810	-1.5280	-1.7465	-1.9320	-2.1000	-2.2400	-2.3500
I= 2 ZVRTX=	0.0000	.2990	.5310	.7390	.9290	1.1028	1.2720	1.4230	1.5510	1.6730
I= 2 GX=	0.0000	-.1910	-.4725	-.6750	-.8510	-1.0080	-1.1510	-1.2830	-1.4060	-1.5200

VORTEX INTERPOLATION TABLE

VORTEX 1

STAT	XV	YVRTX	ZVRTX	AY	AZ	GAM/V
1	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2	2.000	.6530	.2990	.8458	.2820	.1910
3	4.000	.9900	.5310	1.3969	.4456	.4725
4	6.000	1.2810	.7390	1.8585	.6195	.6750
5	8.000	1.5280	.9290	2.2526	.7509	.8510
6	10.000	1.7465	1.1028	2.5917	.8639	1.0080
7	12.000	1.9320	1.2720	2.8866	.9622	1.1510
8	14.000	2.1000	1.4230	3.1272	1.0424	1.2830
9	16.000	2.2400	1.5510	3.3157	1.1052	1.4060
10	18.000	2.3500	1.6730	3.4396	1.1466	1.5200

Figure 26.- Continued.

VORTEX 2

STAT	XV	YVRTX	ZVRTX	AY	AZ	GAM/V
1	0.000	0.0000	0.0000	0.0000	0.0000	0.0000
2	2.000	-.6530	.2990	.8458	.2820	-.1910
3	4.000	-.9900	.5310	1.3968	.4656	-.4725
4	6.000	-1.2810	.7390	1.8585	.6195	-.6750
5	8.000	-1.5280	.9290	2.2526	.7509	-.8510
6	10.000	-1.7465	1.1028	2.5917	.8639	-1.0080
7	12.000	-1.9320	1.2720	2.8866	.9622	-1.1510
8	14.000	-2.1000	1.4230	3.1272	1.0424	-1.2830
9	16.000	-2.2400	1.5510	3.3157	1.1052	-1.4060
10	18.000	-2.3500	1.6730	3.4396	1.1466	-1.5200

VELOCITY ON BODY

** SOLVE **

MACH= 1.700 ALPHA= 10.000 PHIR= 0.000

PANEL NO.	SOURCE STRENGTH	AXIAL VELOCITY	LATERAL VELOCITY	VERTICAL VELOCITY	NORMAL VELOCITY	LAT.VORTEX VELOCITY	VER.VORTEX VELOCITY
1	.60815	-.11784	.16037E-01	-.28250	.29530	-.21087E-03	-.15168E-04
2	.60675	-.11969	.53979E-01	-.28089	.29717	-.73365E-03	-.69852E-04
3	.60245	-.12713	.12055	-.27287	.30478	-.18811E-02	-.36981E-03
4	.62066	-.17190	.34530	-.14717	.34717	-.94219E-02	-.73666E-02
5	-.24230	-.26758E-02	-.78232E-01	.13918	.68542E-01	.13435	-.87685E-01
6	-.35677	.11105E-01	-.64029E-01	-.21314E-01	-.33651E-01	.10521	-.22110E-01
7	-.37133	.94787E-02	-.29829E-01	-.43240E-01	-.46262E-01	.23587E-01	-.23402E-02
8	-.37538	.90032E-02	-.89827E-02	-.48241E-01	-.49180E-01	.60384E-02	-.44081E-03
9	.77418	-.49925E-01	.27541E-01	-.24829	.25206	-.27452E-03	-.19886E-04
10	.72887	-.72574E-01	.82788E-01	-.24231	.25311	-.96108E-03	-.91463E-04
11	.70514	-.84087E-01	.14475	-.22865	.25730	-.24535E-02	-.48204E-03
12	.73049	-.11663	.36678	-.64315E-01	.27580	-.11940E-01	-.93151E-02
13	-.46254	.28511E-01	-.18601	.12620	-.65632E-02	.13497	-.89632E-01
14	-.54706	.23679E-01	-.99542E-01	-.64490E-01	-.83044E-01	.27169	-.57753E-01
15	-.56437	.22294E-01	-.56889E-01	-.86305E-01	-.91981E-01	.53079E-01	-.53230E-02
16	-.59123	.11527E-01	-.18945E-01	-.92995E-01	-.94028E-01	.13175E-01	-.96549E-03
17	.67301	-.70611E-01	.87470E-02	-.23148	.23562	-.30468E-03	-.21911E-04
18	.67160	-.68445E-01	.24471E-01	-.23122	.23636	-.10586E-02	-.10074E-03
19	.74809	-.41681E-01	.11979	-.21898	.23922	-.26983E-02	-.53007E-03
20	.77486	-.89709E-01	.37089	-.34114E-01	.24819	-.12995E-01	-.10132E-01
21	-.55746	.31494E-01	-.22567	.11815	-.35178E-01	.13454	-.90011E-01
22	-.61343	.11864E-01	-.90787E-01	-.86191E-01	-.10163	.35000	-.74316E-01
23	-.56960	.30961E-01	-.20133E-01	-.10615	-.10917	.69585E-01	-.69921E-02
24	-.57469	.31223E-01	-.65845E-02	-.10900	-.11088	.17166E-01	-.12591E-02
25	.69438	-.46635E-01	.19372E-01	-.22082	.22328	-.33639E-03	-.24191E-04
26	.69136	-.53028E-01	.55563E-01	-.21768	.22378	-.11685E-02	-.11119E-03
27	.69179	-.54942E-01	.10612	-.20726	.22563	-.29757E-02	-.58452E-03
28	.79600	-.59261E-01	.35246	-.26411E-01	.22734	-.14244E-01	-.11100E-01
29	-.61080	.26301E-01	-.24216	.10210	-.56628E-01	.13957	-.93826E-01
30	-.59570	.30622E-01	-.91269E-01	-.99251E-01	-.11552	.35000	-.81963E-01
31	-.60161	.26979E-01	-.46534E-01	-.11752	-.12201	.82236E-01	-.82528E-02
32	-.60523	.21438E-01	-.16269E-01	-.12221	-.12348	.20340E-01	-.14915E-02

Figure 26.- Continued.

33	.69517	-.39175E-01	.14733E-01	-.20956	.21119	-.37751E-03	-.27147E-04
34	.69731	-.37754E-01	.47779E-01	-.20705	.21145	-.13111E-02	-.12475E-03
35	.69166	-.43159E-01	.11499	-.19321	.21230	-.33365E-02	-.65531E-03
36	.78268	-.44979E-01	.34976	-.54079E-02	.20677	-.15889E-01	-.12378E-01
37	-.64319	.30170E-01	-.26128	.89072E-01	-.77656E-01	.14840	-.10019
38	-.62337	.32803E-01	-.10279	-.11120	-.12908	.35000	-.84902E-01
39	-.63162	.27081E-01	-.45964E-01	-.13040	-.13453	.93842E-01	-.93865E-02
40	-.63179	.26872E-01	-.13736E-01	-.13455	-.13576	.23403E-01	-.17147E-02
41	.70879	-.20666E-01	.12106E-01	-.19567	.19632	-.43398E-03	-.31208E-04
42	.70667	-.23565E-01	.50166E-01	-.19247	.19629	-.15071E-02	-.14339E-03
43	.69990	-.28498E-01	.10973	-.17848	.19590	-.38331E-02	-.75282E-03
44	.79237	-.19270E-01	.34912	.22758E-01	.18140	-.18192E-01	-.14168E-01
45	-.70788	.29386E-01	-.29248	.78930E-01	-.10341	.16369	-.11091
46	-.66863	.34123E-01	-.99607E-01	-.12910	-.14567	.35000	-.84639E-01
47	-.67059	.30967E-01	-.47305E-01	-.14594	-.14986	.10323	-.10276E-01
48	-.66967	.31067E-01	-.14531E-01	-.14982	-.15079	.26073E-01	-.19075E-02
49	.72405	.10358E-01	.17563E-01	-.16851	.16892	0.	0.
50	.72972	.18017E-03	.58609E-01	-.16429	.16835	0.	0.
51	.70103	-.27017E-02	.10653	-.14903	.16568	0.	0.
52	.80192	.36156E-01	.35251	.81845E-01	.13451	0.	0.
53	-.63150	.24808E-01	-.34667	.57674E-01	-.15052	0.	0.
54	-.75263	.44304E-01	-.10389	-.16023	-.17600	0.	0.
55	-.75308	.40954E-01	-.54426E-01	-.17440	-.17790	0.	0.
56	-.75563	.39542E-01	-.15980E-01	-.17815	-.17828	0.	0.
57	.80566	.32240E-01	.35015E-01	-.14887	.15035	0.	0.
58	.79111	.34623E-01	.80856E-01	-.14277	.14941	0.	0.
59	.76535	.28214E-01	.12924	-.12335	.14518	0.	0.
60	.76222	.54103E-01	.31738	.98433E-01	.10263	0.	0.
61	-.89037	.23917E-01	-.37223	.35782E-01	-.18217	0.	0.
62	-.81693	.34415E-01	-.12483	-.17788	-.19639	0.	0.
63	-.81511	.37500E-01	-.54330E-01	-.19407	-.19674	0.	0.
64	-.81820	.42046E-01	-.21014E-01	-.19738	-.19676	0.	0.
65	.73959	.43137E-01	.13606E-01	-.14433	.14576	0.	0.
66	.74769	.38085E-01	.31969E-01	-.14164	.14473	0.	0.
67	.85206	.56250E-01	.17220	-.10936	.14011	0.	0.
68	.80431	.42808E-01	.33927	.12314	.94731E-01	0.	0.
69	-.90644	.27204E-02	-.39092	.40723E-01	-.18997	0.	0.
70	-.85580	.21286E-01	-.13728	-.18051	-.20141	0.	0.
71	-.79820	.32517E-01	-.51720E-01	-.19898	-.20137	0.	0.
72	-.79912	.24432E-01	-.17669E-01	-.20172	-.20131	0.	0.
73	.82312	.37525E-01	.20165E-01	-.14413	.14556	0.	0.
74	.80987	.52087E-01	.57851E-01	-.13901	.14453	0.	0.
75	.78823	.74790E-01	.11422	-.11910	.13990	0.	0.
76	.81892	.41996E-01	.35553	.13477	.94450E-01	0.	0.
77	-.94559	-.57681E-02	-.41097	.54350E-01	-.19025	0.	0.
78	-.84463	-.41409E-02	-.12342	-.18244	-.20162	0.	0.
79	-.85797	.15042E-01	-.45874E-01	-.19913	-.20157	0.	0.
80	-.86823	.22590E-01	-.80174E-02	-.20210	-.20150	0.	0.

Figure 26.- Continued.

LRC 3/1 ELLIPTIC WING/BODY MISSILE CONFIGURATION - NOSE VORTICITY
ELLIPTIC BODY PANELING - KRAD=9, KFORX=11

INTEGRATION OF THE PRESSURE DISTRIBUTION ** FORMOM **

ON THE BODY

MACH = 1.7000 ALPHAC= 10.0000 PHIR= 0.0000

POINT	X	Y	Z	THETP	CP	CX	CY	CZ	CM	CLN	CLL
1	2.00000	.05169	-.25078	281.64720	.27940	.00819	-.00149	.06499	.95986	-.02161	-.00299
2	2.00000	.17121	-.24431	305.02186	.28070	.01104	-.00667	.08567	1.26526	-.09683	-.01304
3	2.00000	.35647	-.21767	328.59115	.28509	.02128	-.02741	.15066	2.22517	-.39812	-.04774
4	2.00000	.61492	-.09815	350.93129	.26536	.04430	-.11720	.16838	2.48774	-1.70736	-.09204
5	2.00000	.61492	.09815	9.06871	-.01818	-.00303	.00803	.01154	.17044	.11697	-.00631
6	2.00000	.35647	.21767	31.40886	-.01042	-.00078	.00100	.00551	.08131	.01455	-.00174
7	2.00000	.17121	.24431	54.97814	-.00503	-.00020	.00012	.00153	.02266	.00173	-.00023
8	2.00000	.05169	.25078	78.35280	-.00328	-.00010	.00002	.00076	.01126	.00025	-.00004
9	4.62106	.10432	-.50607	281.64720	.13039	.00644	-.00183	.08004	.97159	-.02165	-.00742
10	4.62108	.34550	-.49303	305.02186	.17489	.01160	-.01097	.14087	1.70990	-.12957	-.04326
11	4.62108	.71936	-.43925	328.59112	.18609	.02343	-.04722	.25954	3.15059	-.55827	-.16596
12	4.62107	1.24090	-.19807	350.93123	.11943	.03362	-.13921	.19999	2.42901	-1.65365	-.22060
13	4.62107	1.24090	.19807	9.06877	-.06978	-.01965	.08133	.11685	1.41917	.96617	-.12889
14	4.62108	.71936	.43925	31.40888	-.04759	-.00599	.01208	.06637	.80571	.14277	-.04204
15	4.62108	.34550	.49303	54.97815	-.02068	-.00137	.00130	.01666	.20218	.01532	-.00512
16	4.62108	.10432	.50607	78.35281	.00093	.00005	-.00001	-.00057	-.00697	-.00016	.00005
17	7.56661	.14750	-.71555	281.64719	.18039	.01007	-.00363	.15870	1.45815	-.03207	-.02081
18	7.56661	.48851	-.69710	305.02184	.17489	.01310	-.01572	.20187	1.85485	-.13873	-.08766
19	7.56661	1.01711	-.62107	328.59108	.10136	.01442	-.03686	.20257	1.86148	-.32568	-.18315
20	7.56660	1.75450	-.28005	350.93114	.05610	.01784	-.09371	.13462	1.23799	-.83393	-.20995
21	7.56660	1.75450	.28005	9.06886	-.07716	-.02454	.12889	.18516	1.70274	1.14700	-.28876
22	7.56661	1.01711	.62107	31.40893	-.05810	-.00826	.02113	.11612	1.06707	.18669	-.10499
23	7.56661	.48851	.69710	54.97816	-.03687	-.00276	.00331	.04256	.39101	.02925	-.01848
24	7.56661	.14750	.71555	78.35281	-.03550	-.00198	.00072	.03123	.28695	.00631	-.00409
25	10.54296	.18223	-.88405	281.64719	.12751	.00706	-.00319	.13908	.86397	-.01864	-.02253
26	10.54296	.60355	-.86126	305.02185	.13894	.01032	-.01548	.19883	1.23519	-.09064	-.10667
27	10.54297	1.25663	-.76732	328.59109	.13496	.01903	-.06085	.33441	2.07784	-.35682	-.37354
28	10.54297	2.16767	-.34599	350.93117	.01052	.00332	-.02178	.03128	.19459	-.12906	-.06028
29	10.54297	2.16767	.34599	9.06883	-.06288	-.01983	.13021	.18706	1.16358	.77175	-.36043
30	10.54297	1.25663	.76732	31.40892	-.09134	-.01288	.04118	.22632	1.40621	.24148	-.25280
31	10.54296	.60355	.86126	54.97816	-.02675	-.00199	.00298	.03827	.23777	.01745	-.02053
32	10.54296	.18223	.88405	78.35281	-.01488	-.00082	.00037	.01623	.10081	.00218	-.00263
33	13.52820	.20942	-1.01596	281.64719	.11238	.00541	-.00323	.14105	.45601	-.00944	-.02626
34	13.52820	.69361	-.98977	305.02184	.10721	.00692	-.01375	.17656	.57083	-.04018	-.10886
35	13.52819	1.44413	-.88181	328.59108	.10771	.01320	-.05588	.30712	.99320	-.16378	-.39424
36	13.52818	2.49110	-.39762	350.93115	-.01878	-.00515	.04476	-.06430	-.20834	.13363	.14239
37	13.52818	2.49110	.39762	9.06886	-.06605	-.01810	.15741	.22614	.73269	.46994	-.50075
38	13.52819	1.44413	.88181	31.40893	-.09052	-.01110	.04697	.25812	.83473	.13765	-.33134
39	13.52820	.69361	.98977	54.97816	-.02682	-.00173	.00344	.04417	.14281	.01005	-.02723
40	13.52820	.20942	1.01596	78.35281	-.02454	-.00118	.00071	.03080	.09957	.00206	-.00573
41	16.51560	.22819	-1.10701	281.64719	.07340	.00232	-.00230	.10046	.02600	-.00012	-.02038
42	16.51560	.75577	-1.07847	305.02183	.07725	.00328	-.01080	.13872	.03591	-.00059	-.09319

Figure 26.- Continued.

43	16.51560	1.57354	-.96083	328.59103	.07829	.00631	-.04430	.24343	.06317	-.00267	-.34049
44	16.51559	2.71429	-.43325	350.93104	-.07101	-.01280	.18453	-.26508	-.06985	.01774	.63956
45	16.51559	2.71429	.43325	9.06896	-.06223	-.01122	.16171	.23230	.06121	.01554	-.56046
46	16.51560	1.57354	.96083	31.40897	-.09515	-.00767	.05384	.29586	.07677	.00324	-.41381
47	16.51560	.75577	1.07847	54.97617	-.03434	-.00146	.00480	.06167	.01597	.00026	-.04143
48	16.51560	.22819	1.10701	78.35281	-.03185	-.00101	.00100	.04360	.01128	.00005	-.00684
49	19.49687	.23377	-1.13410	281.64719	.00937	-.00006	-.00030	.01315	-.03538	.00080	-.00273
50	19.49687	.77426	-1.10486	305.02184	.02678	-.00024	-.00384	.04928	-.13264	.01016	-.03392
51	19.49688	1.61204	-.98434	328.59106	.02392	-.00041	-.01387	.07621	-.20512	.03674	-.10920
52	19.49689	2.78073	-.44385	350.93110	-.19561	.00741	.52092	-.74834	2.01489	-1.38427	1.84971
53	19.49689	2.78073	.44385	9.06890	-.16758	.00635	.44627	.64110	-1.72615	-1.18589	-1.58463
54	19.49686	1.61204	.98434	31.40895	-.06657	.00113	.03860	.21212	-.57094	-.10227	-.30395
55	19.49687	.77426	1.10486	54.97816	-.05299	.00047	.00759	.09751	-.26246	-.02011	-.06711
56	19.49687	.23377	1.13410	78.35281	-.00782	.00032	.00154	.06707	-.18052	-.00407	-.01394
57	21.99291	.22750	-1.10368	281.64720	-.03529	.00076	.00074	-.03211	.16539	-.00365	.00649
58	21.99291	.75349	-1.07523	305.02185	-.04517	.00130	.00420	-.05393	.27864	-.02082	.03612
59	21.99291	1.56882	-.95795	328.59110	-.04397	.00240	.01654	-.09089	.46969	-.08211	.12675
60	21.99291	2.70620	-.43195	350.93119	-.21081	.02576	.36418	-.52319	2.70573	-1.82143	1.25854
61	21.99291	2.70620	.43195	9.06881	-.17270	.02111	.29836	.42862	-2.21668	-1.49222	-1.03107
62	21.99291	1.56882	.95795	31.40891	-.05231	.00286	.01967	.10813	-.55875	-.09768	-.15078
63	21.99291	.75349	1.07523	54.97815	-.04681	.00135	.00435	.05588	-.28872	-.02158	-.03743
64	21.99291	.22750	1.10368	78.35281	-.05325	.00114	.00111	.04845	-.25033	-.00550	-.00980
65	23.69567	.21860	-1.06050	281.64719	-.05535	.00096	.00078	-.03387	.23257	-.00514	.00658
66	23.69567	.72402	-1.03317	305.02184	-.04669	.00108	.00292	-.03749	.25741	-.01935	.02413
67	23.69567	1.50744	-.92047	328.59105	-.10794	.00475	.02731	-.15007	1.03043	-.18114	.20108
68	23.69567	2.60029	-.41505	350.93110	-.21421	.02109	.24892	-.35758	2.45702	-1.66161	.82651
69	23.69567	2.60029	.41505	9.06890	-.15303	.01507	.17783	.25546	-1.75529	-1.18705	-.59045
70	23.69567	1.50744	.92047	31.40895	-.03043	.00134	.00770	.04231	-.29049	-.05107	-.05669
71	23.69567	.72402	1.03317	54.97817	-.03722	.00086	.00233	.02989	-.20520	-.01542	-.01923
72	23.69567	.21860	1.06050	78.35281	-.01939	.00033	.00027	.01187	-.08147	-.00180	-.00231
73	24.99668	.21104	-1.02384	281.64719	-.04490	.00065	.00052	-.02274	.18575	-.00413	.00427
74	24.99668	.69899	-.99745	305.02183	-.07521	.00145	.00389	-.04998	.40821	-.03088	.03105
75	24.99669	1.45532	-.88864	328.59103	-.12541	.00460	.02626	-.14428	1.17857	-.20852	.18665
76	24.99669	2.51036	-.40070	350.93104	-.22516	.01845	.21651	-.31103	2.54199	-1.72838	.69403
77	24.99669	2.51036	.40070	9.06896	-.15733	.01289	.15129	.21733	-1.77623	-1.20771	-.48496
78	24.99669	1.45532	.88864	31.40897	.02337	-.00086	-.00489	-.02688	.21959	.03885	.03478
79	24.99668	.69899	.99745	54.97817	-.00245	.00005	.00013	.00163	-.01329	-.00101	-.00101
80	24.99668	.21104	1.02384	78.35281	-.01555	.00022	.00018	.00787	-.06431	-.00143	-.00148

TOTAL COEFFICIENTS

ON THE BODY

REFA= 12.5670 REFD= 3.4641 REFL= 1.0000

XM = 16.6000 ZM = 0.0000

MACH= 1.70000
ALPHAC= 10.00000 ALPHA= 10.00000
PHIR= 0.00000 BETA= 0.00000
CX= .04322

Figure 26.- Continued.

```
     CY=      0.00000
     CZ=       .85386
     CM=      1.94883
    CLN=      0.00000
    CLL=      0.00000
    XCP=      8.89360

     FOLLOWING ARE IN WIND AXIS SYSTEM
     CL=       .83338
     CY=      0.00000
     CD=       .19083
    CMW=      1.94883
  CNYAWW=     0.00000
```

LRC 3/1 ELLIPTIC WING/BODY MISSILE CONFIGURATION - NOSE VORTICITY
ELLIPTIC BODY PANELING - KRAD=9, KFORX=11

INTEGRATION OF THE PRESSURE DISTRIBUTION ** FORMOM **

ON THE BODY FROM XSTART= 0.0000 TO XWLE= 18.0000

MACH = 1.7000 ALPHAC= 10.0000 PHIR= 0.0000

POINT	X	Y	Z	THETP	CP	CX	CY	CZ	CM	CLN	CLL
1	2.00000	.05169	-.25078	281.64720	.27940	.00819	-.00149	.06499	.95986	-.02161	-.00299
2	2.00000	.17121	-.24431	305.02186	.28070	.01104	-.00667	.08567	1.26526	-.29683	-.01304
3	2.00000	.35647	-.21767	328.59115	.28509	.02128	-.02741	.15066	2.22517	-.34812	-.04774
4	2.00000	.61492	-.09815	350.93129	.26536	.04430	-.11720	.16838	2.48774	-1.70736	-.09204
5	2.00000	.61492	.09815	9.06871	-.01818	-.00303	.00803	.01154	.17044	.11697	-.00631
6	2.00000	.35647	.21767	31.40886	-.01042	-.00078	.00100	.00551	.08131	.01455	-.00174
7	2.00000	.17121	.24431	54.97814	-.00503	-.00020	.00012	.00153	.02246	.00173	-.00025
8	2.00000	.05169	.25078	78.35280	-.00328	-.00010	.00002	.00076	.01126	.00025	-.00004
9	4.62108	.10432	-.50607	281.64720	.13039	.00644	-.00183	.08004	.97159	-.02165	-.00742
10	4.62108	.34550	-.49303	305.02186	.17489	.01160	-.01097	.14087	1.70990	-.12957	-.04326
11	4.62108	.71936	-.43925	328.59112	.18609	.02343	-.04722	.25954	3.15059	-.55827	-.16596
12	4.62107	1.24090	-.19807	350.93123	.11943	.03362	-.13921	.19990	2.42901	-1.65365	-.22060
13	4.62107	1.24090	.19807	9.06877	-.06978	-.01965	.08133	.11685	1.41917	.96617	-.12689
14	4.62108	.71936	.43925	31.40888	-.04759	-.00599	.01208	.06637	.80571	.14277	-.04244
15	4.62108	.34550	.49303	54.97815	-.02068	-.00137	.00130	.01666	.20218	.01532	-.00512
16	4.62108	.10432	.50607	78.35281	.00093	.00005	-.00001	-.00057	-.00697	-.00016	.00005
17	7.56661	.14750	-.71555	281.64719	.18039	.01007	-.00363	.15870	1.45815	-.03207	-.02081
18	7.56661	.48851	-.69710	305.02184	.17489	.01310	-.01572	.20187	1.65485	-.13973	-.08766
19	7.56661	1.01711	-.62107	328.59108	.10136	.01442	-.03686	.20257	1.86148	-.32568	-.18315
20	7.56660	1.75450	-.28005	350.93119	.05610	.01784	-.09371	.13462	1.23799	-.83393	-.20995
21	7.56660	1.75450	.28005	9.06886	-.07716	-.02454	.12889	.18516	1.70274	1.14700	-.28876
22	7.56661	1.01711	.62107	31.40893	-.05810	-.00826	.02113	.11612	1.06707	.18669	-.10499
23	7.56661	.48851	.69710	54.97816	-.03687	-.00276	.00331	.04256	.39101	.02925	-.01848
24	7.56661	.14750	.71555	78.35281	-.03550	-.00198	.00072	.03123	.28695	.00631	-.00409
25	10.54296	.18223	-.88405	281.64719	.12751	.00706	-.00319	.13908	.86397	-.01864	-.02253

Figure 26.- Continued.

26	10.54296	.60355	-.86126	305.02185	.13894	.01032	-.01548	.19883	1.23519	-.09964	-.10667
27	10.54297	1.25663	-.76732	328.59109	.13496	.01903	-.06085	.33441	2.07784	-.35682	-.37354
28	10.54297	2.16767	-.34599	350.93117	.01052	.00332	-.02178	.03128	.19459	-.12906	-.06028
29	10.54297	2.16767	.34599	9.06883	-.06288	-.01983	.13021	.18706	1.16358	.77175	-.36043
30	10.54297	1.25663	.76732	31.40892	-.09134	-.01288	.04118	.22632	1.40621	.24148	-.25280
31	10.54296	.60355	.86126	54.97816	-.02675	-.00199	.00298	.03827	.23777	.01745	-.02053
32	10.54296	.18223	.88405	78.35281	-.01488	-.00082	.00037	.01623	.10081	.00218	-.00263
33	13.52820	.20942	-1.01596	281.64719	.11238	.00541	-.00323	.14105	.45601	-.00944	-.02626
34	13.52820	.69361	-.98977	305.02184	.10721	.00692	-.01375	.17656	.57083	-.04018	-.10886
35	13.52819	1.44413	-.88181	328.59108	.10771	.01320	-.05588	.30712	.99320	-.16378	-.39424
36	13.52818	2.49110	-.39762	350.93115	-.01878	-.00515	.04476	-.06430	-.20834	.13363	.14239
37	13.52818	2.49110	.39762	9.06886	-.06605	-.01810	.15741	.22614	.73269	.46994	-.50075
38	13.52819	1.44413	.88181	31.40893	-.09052	-.01110	.04697	.25812	.83473	.13765	-.33134
39	13.52820	.69361	.96977	54.97816	-.02682	-.00173	.00344	.04417	.14281	.01005	-.02723
40	13.52820	.20942	1.01596	78.35281	-.02454	-.00118	.00071	.03080	.09957	.00206	-.00573
41	16.51560	.22819	-1.10701	281.64719	.07340	.00232	-.00230	.10046	.02600	-.00012	-.02038
42	16.51560	.75577	-1.07847	305.02183	.07725	.00328	-.01080	.13872	.03591	-.00059	-.09319
43	16.51560	1.57354	-.96083	328.59103	.07829	.00631	-.04430	.24343	.06317	-.00267	-.34049
44	16.51559	2.71429	-.43325	350.93104	-.07191	-.01280	.19453	-.26508	-.06985	.01774	.63956
45	16.51559	2.71429	.43325	9.06896	-.06223	-.01122	.16171	.23230	.06121	.01554	-.56046
46	16.51560	1.57354	.96083	31.40897	-.09515	-.00767	.05384	.29586	.07677	.00324	-.41381
47	16.51560	.75577	1.07847	54.97817	-.03434	-.00146	.00480	.06167	.01597	.00026	-.04143
48	16.51560	.22819	1.10701	78.35281	-.03185	-.00101	.00100	.04360	.01128	.00005	-.00884

```
          TOTAL COEFFICIENTS
          ------------------
          ON THE BODY FROM XSTART=    0.0000 TO XWLE=   18.0000


          REFA=        12.5670   REFD=        3.4641   REFL=        1.0000

          XM   =       16.8000   ZM   =       0.0000

         MACH=        1.70000
       ALPHAC=       10.00000         ALPHA=       10.00000
         PHIR=        0.00000          BETA=        0.00000
          CX=          .01861
          CY=         0.00000
          CZ=          .88865
          CM=         1.78654
         CLN=         0.00000
         CLL=         0.00000
         XCP=         9.83566

          FOLLOWING ARE IN WIND AXIS SYSTEM
          CL=          .87190
          CY=         0.00000
          CD=          .17264
         CMW=         1.78654
      CNYAWW=         0.00000

CPSTAG =   1.94562   CPCRIT =    .79466   CPVAC =   -.49431

    END SOLVE,   TIME=    6.4530     DT=    1.0900
```

Figure 26.- Continued.

PERTURBATION VELOCITIES AT SPECIFIED CONTROL POINTS BY SOURCE PANELS

JCPT	CONTROL POINT X	Y	Z	PANEL ANGLES THET	DELTA	VELOCITIES U	V	W	NORMAL
1	21.98180	3.64130	0.00000	0.00000	.12529	.03077	-.03893	.27791	.27188
2	25.47690	3.64130	0.00000	0.00000	.12773	.01671	-.03515	.20167	.19790
3	22.79380	4.00490	0.00000	0.00000	.13810	.02826	-.03358	.17286	.16732
4	25.71560	4.00490	0.00000	0.00000	.21266	.01619	-.02840	.14465	.13797
5	23.60470	4.36790	0.00000	0.00000	.21266	.02664	-.03169	.12540	.11695
6	25.95390	4.36790	0.00000	0.00000	.13810	.01549	-.02418	.11203	.10923
7	21.58590	2.81800	.44979	0.00000	.12773	.02376	-.35273	.05990	.05639
8	21.58590	1.63360	.99752	0.00000	.12529	.03627	-.12796	-.17431	-.17747
9	21.58590	.78462	1.11960	0.00000	.08032	.03568	-.05563	-.18569	-.18796
10	21.58590	.23690	1.14930	0.00000	.08190	.04522	-.01440	-.19518	-.19823
11	21.58590	.23690	-1.14930	0.00000	.08859	.01995	.02000	-.15368	-.15484
12	21.58590	.78462	-1.11960	0.00000	.13713	.04230	.08505	-.12776	-.13234
13	21.58590	1.63360	-.99752	0.00000	.13713	.02622	.11854	-.12042	-.12288
14	21.58590	2.81800	-.44979	0.00000	.08859	.05307	.30334	.12184	.11666
15	25.36050	2.81800	.44979	0.00000	.08190	-.00575	-.33630	.14262	.14262
16	25.36050	1.63360	.99752	0.00000	.08032	.00208	-.13981	-.18074	-.18033
17	25.36050	.78462	1.11960	0.00000	.06337	.00767	-.06356	-.19388	-.19397
18	25.36050	.23690	1.14930	0.00000	.06462	.02787	-.01179	-.20495	-.20632
19	25.36050	.23690	-1.14930	0.00000	.06991	.03946	.01976	-.13909	-.14150
20	25.36050	.78462	-1.11960	0.00000	.10836	.05313	.06701	-.13473	-.13968
21	25.36050	1.63360	-.99752	0.00000	.10836	.05702	.12708	-.11184	-.11735
22	25.36050	2.81800	-.44979	0.00000	.06991	.04292	.27085	.21186	.20835

Figure 26.- Concluded.

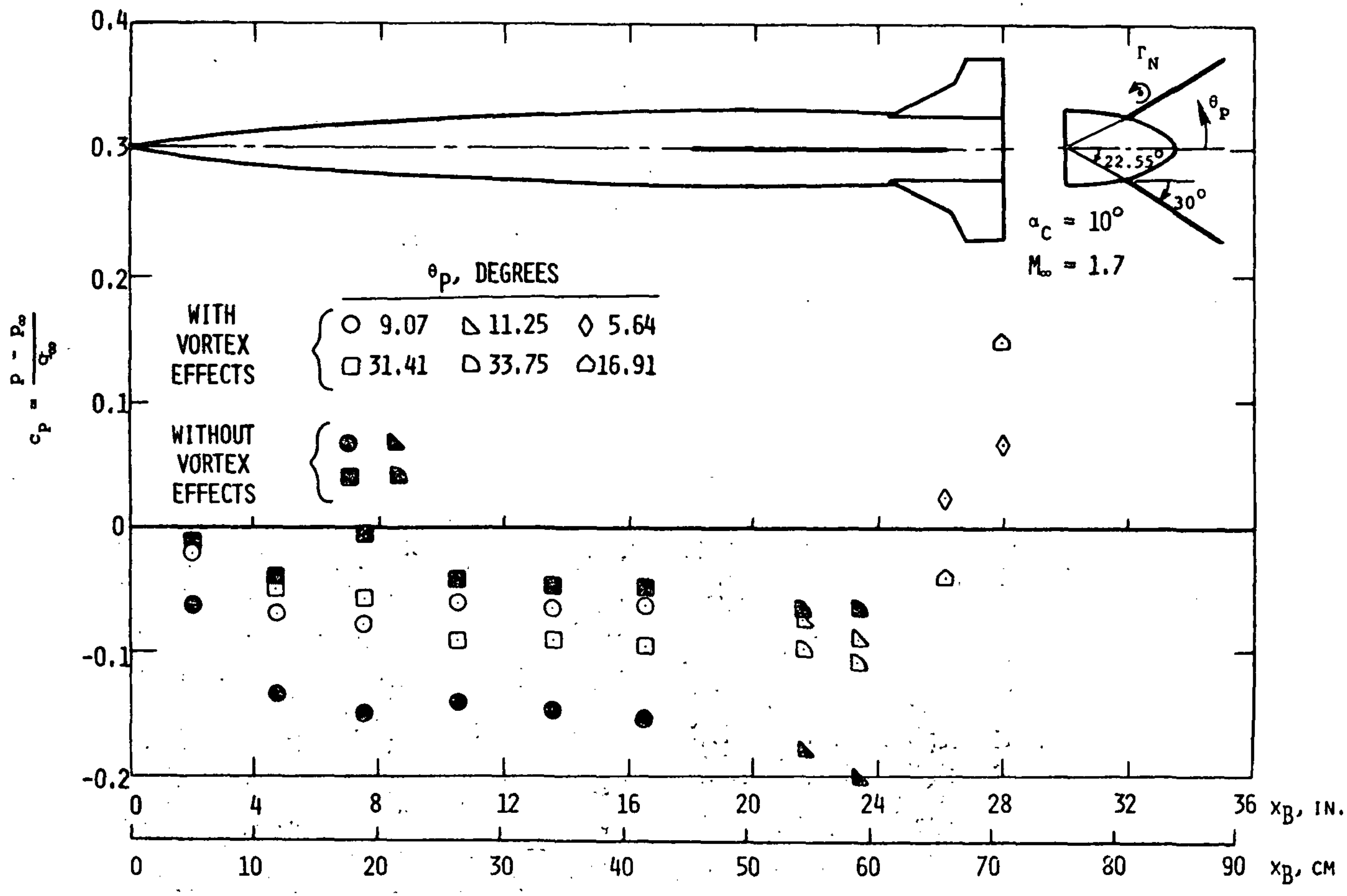


Figure 27(a).- Calculated pressure distributions, second sample case.

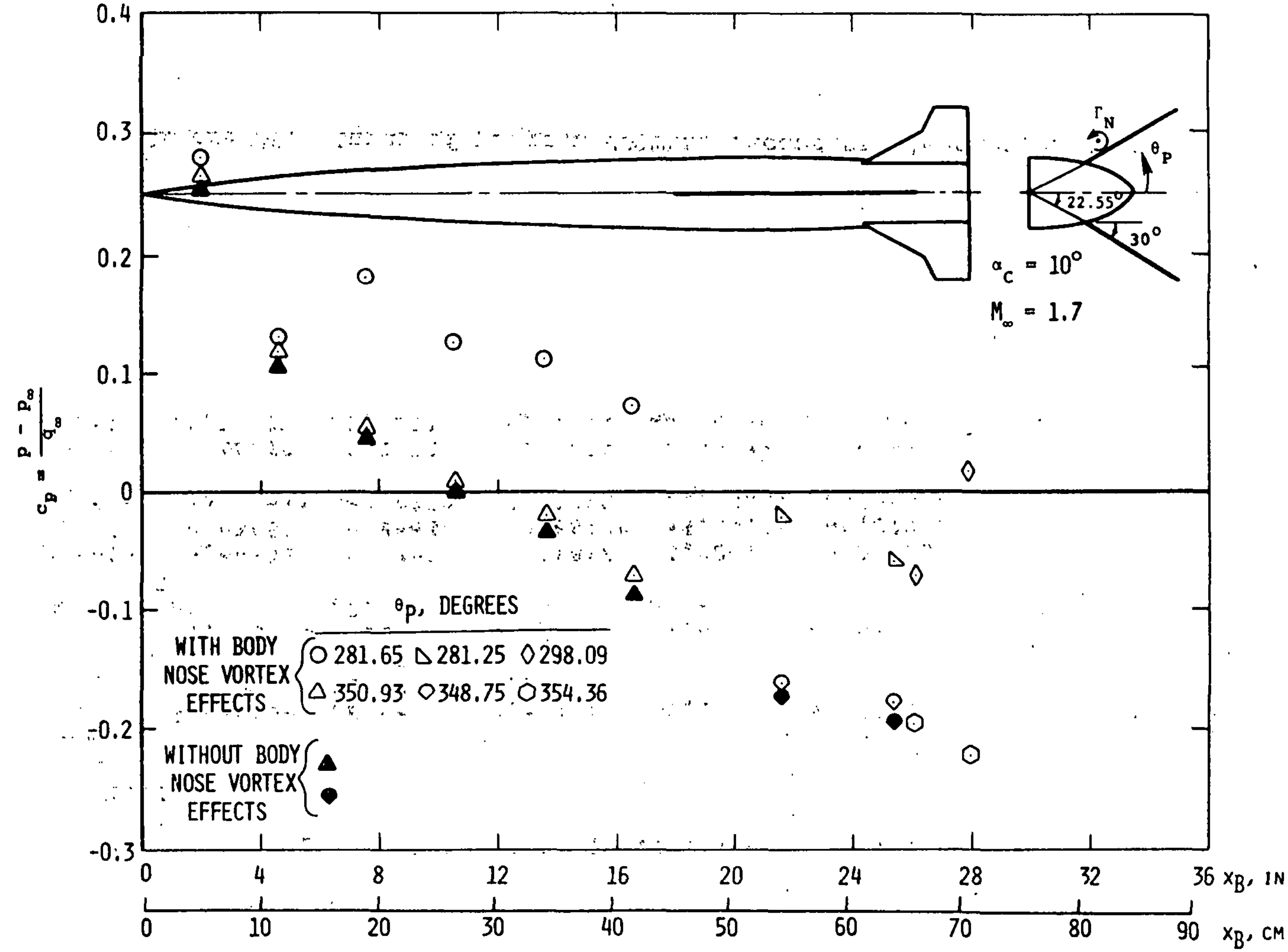


Figure 27(b).- Concluded.

```
LRC 3/1 ELLIPTICAL BODY/MONOPLANE WING,TRACK BODY NOSE VORTICES.
          1         4         5         1         1         0         0
0.3333333
25.55
3.464106
  18.0     3.464106  22.081    4.55761   25.55     4.55761   25.56     3.464106
   10.0      0.0      0.0001    0.50
    2     2    2    2    2
  2.35      1.673     1.52     -2.35      1.673    -1.52
  18.0     20.0      22.0      24.0      25.55
          3         3
 0.66148   3.64135   0.27984   2.01812   3.82511   0.27786
 3.37295   4.03457   0.28634   0.66148  -3.64135  -0.27984
2.01812   -3.82511  -0.27786   3.37295  -4.03457  -0.28634
          2
  4.081    4.34073   0.44937   6.13099   4.40075   0.58150
  4.081   -4.34073  -0.44937   6.13099  -4.40075  -0.58150
```

Figure 28.- Input of program VPATHL, second sample case, step 4.

LRC 3/1 ELLIPTICAL BODY/MONOPLANE WING,TRACK BODY NOSE VORTICES.

```
          FIN GEOMETRY
FIN SEMISPAN                 =    4.55761
FIN ROOTCHORD                =    7.56000
FIN ROOT L.E. X-STATION=  18.00000
         L.E. Y-STATION=   3.46411
FIN TIP L.E. X-STATION =  22.08100
        L.E. Y-STATION =   4.55761
FIN TIP T.E. X-STATION =  25.55000
        T.E. Y-STATION =   4.55761
FIN ROOT T.E. X-STATION=  25.56000
         T.E. Y-STATION=   3.46411
```

INCLUDED ANGLE OF ATTACK(DEG) =   10.00000   ROLL ANGLE(DEG) =   0.00000

FIN LEADING EDGE VORTICITY

JLE	X	Y OR Z BAR	GAMMA/VINF.
1	18.66148	3.64135	.27984
2	20.01812	3.82511	.27786
3	21.37295	4.03457	.28634
4	18.66148	-3.64135	-.27984
5	20.01812	-3.82511	-.27786
6	21.37295	-4.03457	-.28634

FIN SIDE EDGE VORTICITY

JSE	X	Y OR Z BAR	GAMMA/VINF.
1	22.08100	4.34073	.44937
2	24.13099	4.40075	.58150
3	22.08100	-4.34073	-.44937
4	24.13099	-4.40075	-.58150

****PERMISSIBLE RELATIVE ERROR,ES,USED IN INTEGRATION SCHEME =   .10000E-03

VORTEX COORDINATES IN CROSS-FLOW PLANE

Figure 29.- Output of program VPATHL, second sample case, step 4.

INITIAL VORTEX POSITIONS AT X = 18.000

LOCAL BODY HORIZONTAL SEMI-AXIS = 3.46411
LOCAL BODY VERTICAL SEMI-AXIS = 1.15470
LOCAL SEMI SPAN S = 3.46411

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	.23500E+01	.16730E+01	.15200E+01
2	-.23500E+01	.16730E+01	-.15200E+01

X-STATION NO. 2 X=20.000 INTEGRATION STEP SIZE = 1.00000

LOCAL BODY HORIZONTAL SEMI-AXIS = 3.46411
LOCAL BODY VERTICAL SEMI-AXIS = 1.15470
LOCAL SEMI SPAN S = 4.00001

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	.23864E+01	.17470E+01	.15200E+01
2	-.23864E+01	.17470E+01	-.15200E+01

X-STATION NO. 3 X=22.000 INTEGRATION STEP SIZE = 1.00000

LOCAL BODY HORIZONTAL SEMI-AXIS = 3.46411
LOCAL BODY VERTICAL SEMI-AXIS = 1.15470
LOCAL SEMI SPAN S = 4.53591

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	.24152E+01	.18080E+01	.15200E+01
2	-.24152E+01	.18080E+01	-.15200E+01

X-STATION NO. 4 X=24.000 INTEGRATION STEP SIZE = 1.00000

LOCAL BODY HORIZONTAL SEMI-AXIS = 3.46411
LOCAL BODY VERTICAL SEMI-AXIS = 1.15470
LOCAL SEMI SPAN S = 4.55761

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	.24432E+01	.18508E+01	.15200E+01
2	-.24432E+01	.18508E+01	-.15200E+01

X-STATION NO. 5 X=25.550 INTEGRATION STEP SIZE = 1.00000

Figure 29.- Continued.

LOCAL BODY HORIZONTAL SEMI-AXIS = 3.46411
LOCAL BODY VERTICAL SEMI-AXIS = 1.15470
LOCAL SEMI SPAN S = 4.55761

VORTEX	Y,VRTX	Z,VRTX	GAMMA/VINF
1	.24609E+01	.18792E+01	.15200E+01
2	-.24609E+01	.18792E+01	-.15200E+01

CROSSFLOW VELOCITIES AT CONTROL POINTS INDUCED BY VORTICES AND THEIR IMAGES

IC	X,BODY	Y,BODY	Z,BODY	V	W
1	.21982E+02	.36413E+01	0.	.22027E-01	-.73043E-01
2	.25477E+02	.36413E+01	0.	.23261E-01	-.78140E-01
3	.22794E+02	.40049E+01	0.	.32848E-01	-.38784E-01
4	.25716E+02	.40049E+01	0.	.34452E-01	-.41193E-01
5	.23605E+02	.43679E+01	0.	.32109E-01	-.21043E-01
6	.25954E+02	.43679E+01	0.	.33399E-01	-.22172E-01
7	.21586E+02	.31556E+01	.50368E+00	.18131E+00	-.12379E+00
8	.21586E+02	.16764E+01	.10237E+01	.38057E+00	-.75801E-01
9	.21586E+02	.79588E+00	.11357E+01	.11080E+00	-.10914E-01
10	.21586E+02	.23983E+00	.11635E+01	.28788E-01	-.20990E-02
11	.21586E+02	.23983E+00	-.11635E+01	-.52670E-03	-.37374E-04
12	.21586E+02	.79588E+00	-.11357E+01	-.18287E-02	-.17398E-03
13	.21586E+02	.16764E+01	-.10237E+01	-.46457E-02	-.91229E-03
14	.21586E+02	.31556E+01	-.50368E+00	-.21879E-01	-.17031E-01
15	.25361E+02	.31556E+01	.50368E+00	.18892E+00	-.12949E+00
16	.25361E+02	.16764E+01	.10237E+01	.35303E+00	-.69873E-01
17	.25361E+02	.79588E+00	.11357E+01	.11003E+00	-.10781E-01
18	.25361E+02	.23983E+00	.11635E+01	.29018E-01	-.21119E-02
19	.25361E+02	.23983E+00	-.11635E+01	-.57450E-03	-.41311E-04
20	.25361E+02	.79588E+00	-.11357E+01	-.19944E-02	-.18974E-03
21	.25361E+02	.16764E+01	-.10237E+01	-.50641E-02	-.99439E-03
22	.25361E+02	.31556E+01	-.50368E+00	-.23762E-01	-.18491E-01

Figure 29.- Concluded.

```
IDEALIZED LRC ELLIPTICAL BODY MONOPLANE WING
$INPUT
CRP=7.54926,  SWLEP=75.0,  SWTEP=30.03564, B2=1.0935, BIL=7.54926,
XWLE=18.0,
RB=3.464106,  RA=1.1547005,  ERATIO=3.0,
NCW=2, MSWR=3, MSWL=0, NBDCR=8, NCWB=2,
NBDCR=16,
ALFAC=10.0,  PHI=0.0,  FMACH=1.7,
SREF=12.567,  REFL=3.464106,
NDLINP=1, NDRAG=1, NBDYPR=1,
NOUT=0,
NCPOUT=0,
NVLIN=1,
NTDAT=1,NCWT=4,
XM=16.8,ZM=0.0,
$END
    3     0     0
0.049692     0.0      0.0      -0.07889
0.049692  0.049692    0.0      -0.07889
0.049692  0.049692    0.0      -0.07889
         0          0          0          0
         0
ZZZZZZZZZZZZ
```

Figure 30.- Input of program DEMON2, second sample case, step 5.

```
IDEALIZED LRC ELLIPTICAL BODY NONPLANE WING
 $INPUT
 CRP     = .754926E+01,                    SREF    = .12567E+02,
 SWLEP   = .75E+02,                        REFL    = .34641016E+01,
 SWTEP   = .30015604E+02,                  PHIDIH  = 0.0,
 NCW     = 2,                              THETIT  = 0.0,
 MSWR    = 3,                              XWLE    = .18E+02,
 MSWL    = 0,                              NOLINP  = 1,
 ALFAC   = .1E+02,                         NOUT    = 0,
 PHI     = 0.0,                            NPR     = 0,
 B2      = .10935E+01,                     NDRAG   = 1,
 FMACH   = .17E+01,                        NVRTX   = 0,
 LVSWP   = 0,                              NPRESS  = 0,
 FAC     = .95E+00,                        VRTMAX  = .35E+00,
 NEVNPR  = 0,                              NCWB    = 2,
 TOLFAC  = .1E+01,                         NAGAIN  = 0,
 MSWU    = 0,                              BIL     = .754926E+01,
 MSWD    = 0,                              ITAIL   = 0,
 SWLEV   = 0.0,                            NVRTPL  = 0,
 SWTEV   = 0.0,                            NBDYPR  = 1,
 CRPV    = 0.0,                            NTPR    = 0,
 B2V     = 0.0,                            NTDAT   = 1,
 NCRX    = 0,                              NCWT    = 4,
 RB      = .34641016E+01,                  NCPOUT  = 0,
 RA      = .11547005E+01,                  NVLIN   = 1,
 ERATIO  = .30000038971145E+01,            XSTART  = 0.0,
 NBDCR   = 16,                             JCPT    = 0,
 DELR    = 0.0,                            FKLE    = .5E+00,
 DELL    = 0.0,                            FKSE    = .5E+00,
 DELU    = 0.0,                            XM      = .168E+02,
 DELD    = 0.0,                            ZM      = 0.0,
                                           $END
```

Figure 31.- Output of program DEMON2, second sampel case, step 5.

WING GEOMETRY

TIP CHORD = 4.09999

ROOT CHORD = 7.54926

WING SEMISPAN = 1.09350

LEADING EDGE SWEEP = 75.00000 DEGREES

TRAILING EDGE SWEEP = 30.01564 DEGREES

FLOW CONDITIONS

MACH = 1.70000 ALPHAC= 10.00000 PHI = 0.00000 ALFA = 10.00000 BETA = 0.00000

CRPT = 7.54926

WING THICKNESS INPUT DATA

SPANWISE LOCATIONS OF PANEL SIDE EDGES AND SWEEP ANGLES
OF WING SECTION TO THE LEFT

I	SPANWISE LOCATION FEET	LE SWEEP DEGREES	TE SWEEP DEGREES
RIGHT WING SURFACE			
1	3.46411	0.00000	0.00000
2	3.82861	75.00000	30.01564
3	4.19311	75.00000	30.01564
4	4.55761	75.00000	30.01564

12 THICKNESS PANELS ARE TO BE LAID OUT
3 CHORDWISE ROWS WITH 4 IN EACH ROW

INPUT VALUES OF THE LOCAL SURFACE SLOPE OF THE THICKNESS
DISTRIBUTION, FOR EACH CHORDWISE ROW THE FIRST VALUE
IS FOR THE PANEL NEAREST THE LEADING EDGE

RIGHT WING SURFACE

ROW	SLOPES			
1	.04969	0.00000	0.00000	-.07889
2	.04969	.04969	0.00000	-.07889
3	.04969	.04969	0.00000	-.07889

Figure 31.- Continued.

BODY UNDER CONSIDERATION HAS ELLIPTICAL CROSS SECTION.
INTERFERENCE SHELL HAS FOLLOWING PROPERTIES:
HORIZONTAL SEMI-AXIS = 1.40411
VERTICAL SEMI-AXIS = 1.15470

POINT COORDINATES AND PERTURBATION VELOCITIES CALCULATED BY PROGRAM VPATH OR VPATHL

IC	XCP	YCP	ZCP	VVEL(IC)	WVEL(IC)
1	21.98200	3.64130	0.00000	.22027E-01	-.73045E-01
2	25.47700	3.64130	0.00000	.23261E-01	-.78140E-01
3	22.79400	4.00490	0.00000	.32848E-01	-.38784E-01
4	25.71600	4.00490	0.00000	.34452E-01	-.41193E-01
5	23.60500	4.36790	0.00000	.32109E-01	-.21043E-01
6	25.95400	4.36790	0.00000	.33399E-01	-.22172E-01
7	21.58600	3.15560	.50368	.18131E+00	-.12379E+00
8	21.58600	1.67640	1.02370	.38057E+00	-.75801E-01
9	21.58600	.79588	1.13570	.11080E+00	-.10914E-01
10	21.58600	.23983	1.16350	.28788E-01	-.20990E-02
11	21.58600	.23983	-1.16350	-.52670E-03	-.37874E-04
12	21.58600	.79588	-1.13570	-.18287E-02	-.17398E-03
13	21.58600	1.67640	-1.02370	-.46457E-02	-.91229E-03
14	21.58600	3.15560	-.50368	-.21879E-01	-.17031E-01
15	25.36100	3.15560	.50368	.18992E+00	-.12949E+00
16	25.36100	1.67640	1.02370	.35303E+00	-.69873E-01
17	25.36100	.79588	1.13570	.11003E+00	-.10781E-01
18	25.36100	.23983	1.16350	.29018E-01	-.21119E-02
19	25.36100	.23983	-1.16350	-.57450E-03	-.41311E-04
20	25.36100	.79588	-1.13570	-.19448E-02	-.18974E-03
21	25.36100	1.67640	-1.02370	-.50641E-02	-.99439E-03
22	25.36100	3.15560	-.50368	-.23762E-01	-.18491E-01

CONTROL POINT COORDINATES FOR 2 CHORDWISE BY 3 SPANWISE PANELS ON WING 1 OR R, 0 SPANWISE ON WING 2 OR L
AND 0 SPANWISE PANELS ONWING 3 OR U, 0 SPANWISE ON WING 4 OR D

J	X(J)	Y(J)	Z(J)	BU(J)	BV(J)	BW(J)	VVRTX	WVRTX
1	3.98181	3.64135	0.00000	.30766E-01	-.38935E-01	.27791E+00	0.	0.
2	7.47690	3.64135	0.00000	.16709E-01	-.35151E-01	.20167E+00	0.	0.
3	4.79380	4.00486	0.00000	.28259E-01	-.33580E-01	.17286E+00	0.	0.
4	7.71557	4.00486	0.00000	.16194E-01	-.28395E-01	.14465E+00	0.	0.
5	5.60471	4.36789	0.00000	.26643E-01	-.31692E-01	.12540E+00	0.	0.
6	7.95393	4.36789	0.00000	.15490E-01	-.24185E-01	.11243E+00	0.	0.

CONTROL POINT COORDINATES FOR BIP*S (WING FRAME)

J	X(J)	Y(J)	Z(J)	THU(J)	THV(J)	THW(J)
7	3.58590	2.81795	.44979	-.14293E-02	-.50900E-02	.19263E-02
8	3.58590	1.63362	.99752	-.21755E-02	-.28706E-02	.14883E-02
9	3.58590	.78462	1.11965	0.	0.	0.
10	3.58590	.23690	1.14927	0.	0.	0.
11	3.58590	.23690	-1.14927	0.	0.	0.
12	3.58590	.78462	-1.11965	0.	0.	0.
13	3.58590	1.63362	-.99752	-.21755E-02	-.28706E-02	-.14883E-02
14	3.58590	2.81795	-.44979	-.14293E-02	-.50900E-02	-.19263E-02

Figure 31.- Continued.

15	7.36053	2.81795	.44979	.11729E-01	.12612E-01	-.75118E-02
16	7.36053	1.63362	.99752	-.37810E-02	-.42403E-02	.22634E-02
17	7.36053	.78462	1.11965	-.25780E-02	.13263E-02	.11738E-02
18	7.36053	.23690	1.14927	-.26999E-02	.79477E-03	.13010E-02
19	7.36053	.23690	-1.14927	-.26999E-02	.79477E-03	-.13010E-02
20	7.36053	.78462	-1.11965	-.25780E-02	.13263E-02	-.11738E-02
21	7.36053	1.63362	-.99752	-.37810E-02	-.42403E-02	-.22634E-02
22	7.36053	2.81795	-.44979	.11729E-01	.12612E-01	.75118E-02

LOADING INFORMATION

MACH NUMBER =	.17000E+01
ANGLE OF ATTACK =	10.000 DEGREES
SIDE SLIP ANGLE =	0.000 DEGREES
WING AREA =	12.73846
REFERENCE AREA =	12.56700
REFERENCE LENGTH =	3.46411
EXPOSED WING SPAN B =	2.18700
MOMENT CENTER: XM =	16.80000
ZM =	0.00000

U/VINF TYPE LOADING PRESSURE

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
DEFL. ANGLE DEG. =		0.00000	0.00000	0.00000	0.00000	
CTHR =	.29818E-01	.10409E-01	.10409E-01	0.	0.	
CZ =	.47064E+00	.95932E-01	.95932E-01	0.	0.	.27878E+00
CY =	0.	0.	0.	0.	0.	0.
CM =	-.10223E+01	-.18717E+00	-.18717E+00	0.	0.	-.64798E+00
CLN =	0.	0.	0.	0.	0.	0.
CLL =	0.	-.10990E+00	.10990E+00	0.	0.	0.

FOLLOWING ARE IN WIND-AXIS SYSTEM

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
CL =	.46711E+00	.96282E-01	.96282E-01	0.	0.	.27454E+00
CYWIND =	0.	0.	0.	0.	0.	0.
CDI =	.61224E-01	.64074E-02	.64074E-02	0.	0.	.48410E-01
CDI/CL**2 =	.28060E+00					
CMWIND =	-.10223E+01	-.18717E+00	-.18717E+00	0.	0.	-.64798E+00
CLNWIND =	0.	.19084E-01	-.19084E-01	0.	0.	0.

Figure 31.- Continued.

--------------------RIGHT WING--------------------

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*B)	CT*C/(2*B)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSIN)	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
1	3,32999	,27982	,02268	,06378	,02942	,08743	,03194	3,64135	-,61334	,19406	,66148
2	3,66242	,27199	,02547	,07117	,09879	,09843	,06782	3,83365	,01657	,19763	2,01812
3	3,99441	,20436	,03423	,10075	,10075	,13225	,11602	4,05562	,14759	,21123	3,37295
4	4,16791	0,00000							,44919		

SUMFX = ,10452E-01
SUMFY1 = ,29902E-01
SUMFY2 = -,85395E-03
SUMFT2 = ,10511E+00

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	,50000	,09399	,35606	4,36126	4,08100
2	2	1,00000	,06318	,47179	4,41928	6,13099

****T.E. FIN VORTEX INFO*****

IVRT	GAMMA/VINF	Y.C.G.
1	,61196	4,44912

VELOCITIES AND BERNOULLI PRESSURES AT CONTROL POINTS IMMEDIATELY ABOVE AND BELOW HORIZONTAL WING SURFACE

J	X(J)	Y(J)	Z(J)	UTOTA	VTOTA	WTOTA	PRESSA	UTOTB	VTOTB	WTOTB	PRESSB
1	3,981812	3,641349	0,000000	,079046	-,240461	-,173648	-,165036	-,028511	,160947	-,173648	,062203
2	7,476901	3,641349	0,000000	,067994	-,025306	-,252538	-,105974	,000063	,121077	-,094758	,009207
3	4,793803	4,004860	0,000000	,078117	-,278806	-,123956	-,180050	-,072305	,282578	-,223340	,090370
4	7,715573	4,004860	0,000000	,062914	-,027248	-,252538	-,097007	,009085	,088748	-,094758	-,001919
5	5,604708	4,367885	0,000000	,115213	-,318855	-,123956	-,249191	-,055308	,317540	-,223340	,033511
6	7,953725	4,367885	0,000000	,037632	-,036340	-,252538	-,050934	,016947	,008231	-,094758	-,009734

Figure 31.- Continued.

PRESSURE LOADINGS AT CONTROL POINTS

I	X(J)	Y(J)	Z(J)	DELTP,LIN.	DELTP,BERN.
1	3.981812	3.641349	0.000000	.215114	.227239
2	7.476901	3.641349	0.000000	.135861	.115181
3	4.793803	4.004860	0.000000	.300845	.270421
4	7.715573	4.004860	0.000000	.107659	.095088
5	5.604708	4.367885	0.000000	.341043	.282701
6	7.953925	4.367885	0.000000	.041370	.041200

LOADING INFORMATION

MACH NUMBER = .17000E+01
ANGLE OF ATTACK = 10.000 DEGREES
SIDE SLIP ANGLE = 0.000 DEGREES
WING AREA = 12.73846
REFERENCE AREA = 12.56700
REFERENCE LENGTH = 3.46411
EXPOSED WING SPAN B = 2.18700
MOMENT CENTER: XM = 14.80000
ZM = 0.00000

BERNOULLI TYPE LOADING PRESSURE

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
DEFL. ANGLE DEG. =		0.00000	0.00000	0.00000	0.00000	
CTHR =	.18894E-01	.94469E-02	.94469E-02	0.	0.	
CZ =	.45372E+00	.87468E-01	.87468E-01	0.	0.	.27878E+00
CY =	0.	0.	0.	0.	0.	0.
CM =	-.98555E+00	-.16879E+00	-.16879E+00	0.	0.	-.64798E+00
CLN =	0.	0.	0.	0.	0.	0.
CLL =	0.	-.99789E-01	.99789E-01	0.	0.	0.

FOLLOWING ARE IN WIND-AXIS SYSTEM

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
CL =	.45010E+00	.87779E-01	.87779E-01	0.	0.	.27454E+00
CY-IND =	0.	0.	0.	0.	0.	0.
CDT =	.60180E-01	.58852E-02	.58852E-02	0.	0.	.48410E-01
CDT/CL**2 =	.29705E+00					
CM-IND =	-.98555E+00	-.16879E+00	-.16879E+00	0.	0.	-.64798E+00
CLN-IND =	0.	.17328E-01	-.17328E-01	0.	0.	0.

Figure 31.- Continued.

********************RIGHT WING**********************

SPANWISE DISTRIBUTIONS

I	Y/(B/2)	CN*C/(2*H)	CT*C/(2*H)	CY1*C/(2*B)	CYTOT*C/(2*B)	CS*C/(2*B)	CSINT	YBAR	GAMNET(I)	GAMMA,LE/VINF	XLE
1	3.32999	.27300	.02356	.06683	.07818	.09105	.03319	3.64135	-.59839	.20163	.66148
2	3.66242	.24336	.02286	.06392	.10176	.08833	.06538	3.82035	.06403	.19764	2.01812
3	3.99441	.17309	.02837	.08352	.08352	.10963	.10534	4.02865	.15351	.20115	3.37295
4	4.16791	0.00000							.38046		

SUMFY = .94890E-02
SUMFY1 = .27183E-01
SUMFY2 = .62412E-02
SUMFT2 = .87896E-01

SIDE EDGE DISTRIBUTION

JTIP	JSE	DISTANCE FROM LE /TIPCHORD	SUCTION FORCE PER UNIT LENGTH /(Q*TIPCHORD)	GAMMA,SE /VINF	YBAR	XSE
1	1	.50000	.07791	.31398	4.33889	4.08100
2	2	1.00000	.05351	.01103	4.40173	6.13099

*****T.E. FIN VORTEX INFO*****

I/RT	GAMMA/VINF	Y.C.G.
1	.59700	4.38465

****
AFT OF LEADING EDGE OF FIN ROOTCHORDS

PRESSURE COEFFICIENTS AT POINTS ON BODY MERIDIANS

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.

Figure 31.- Continued.

BODY RING= 1

1	11.25000	21.58590	2.81795	.44979	.03566	-.15872	-.07273	-.07133	-.07258	0.00000	.85317	.85570
2	33.75000	21.58590	1.63362	.99752	.04018	.25728	-.25096	-.08036	-.11227	0.00000	.77289	.83743
3	56.25000	21.58590	.78462	1.11965	.04365	.06333	-.19724	-.08730	-.05954	0.00000	.87956	.82340
4	78.75000	21.58590	.23690	1.14927	.04888	.01555	-.19731	-.09777	-.06592	0.00000	.86665	.80222
5	281.25000	21.58590	.23690	-1.14927	.02338	.02071	-.15369	-.04675	-.01705	0.00000	.96551	.90542
6	303.75000	21.58590	.78462	-1.11965	.04490	.08727	-.12762	-.08980	-.06656	0.00000	.86534	.81833
7	326.25000	21.58590	1.63362	-.99752	.02139	.11089	-.12188	-.04278	-.02688	0.00000	.94563	.91345
8	348.75000	21.58590	2.81795	-.44979	.03800	.26433	.09288	-.07599	-.16311	0.00000	.67003	.84627

BODY RING= 2

1	11.25000	25.36053	2.81795	.44979	.04331	-.11684	-.00815	-.08663	-.09132	0.00000	.81526	.82475
2	33.75000	25.36053	1.63362	.99752	.04291	.24035	-.25555	-.08502	-.10983	0.00000	.77751	.82801
3	56.25000	25.36053	.78462	1.11965	.07093	.10105	-.20891	-.14186	-.11497	0.00000	.76741	.71302
4	78.75000	25.36053	.23690	1.14927	.06584	.03170	-.20739	-.13169	-.09814	0.00000	.80146	.73360
5	281.25000	25.36053	.23690	-1.14927	.04433	.02233	-.13906	-.08866	-.05820	0.00000	.88227	.82064
6	303.75000	25.36053	.78462	-1.11965	.06190	.08776	-.13315	-.12580	-.09722	0.00000	.80332	.74955
7	326.25000	25.36053	1.63362	-.99752	.03616	.11786	-.11359	-.07232	-.05733	0.00000	.88402	.85369
8	348.75000	25.36053	2.81795	-.44979	.02213	.24577	.19245	-.04425	-.17885	0.00000	.63819	.91047

Figure 31.- Concluded.

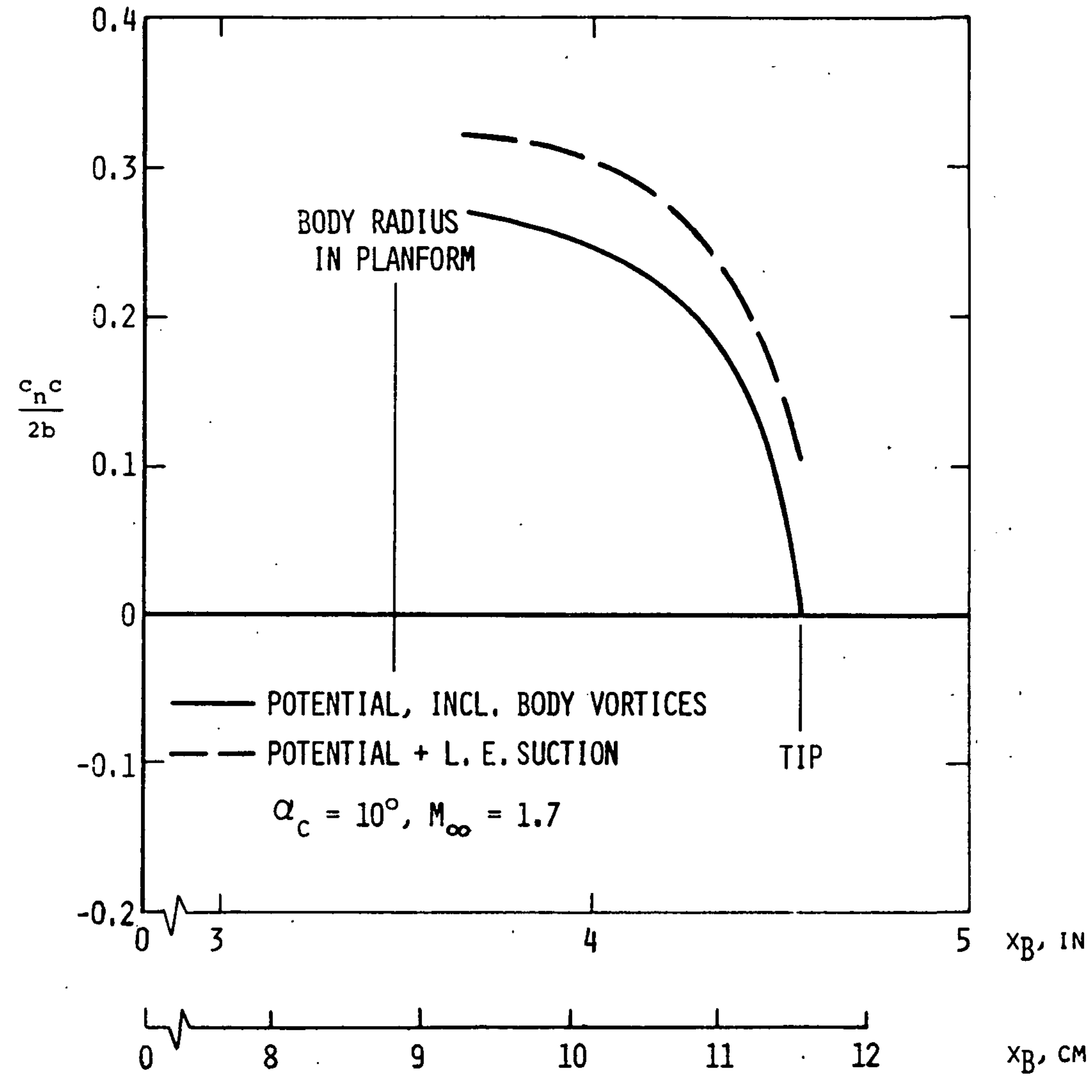


Figure 32.- Calculated span-load distribution on monoplane wing, second sample case.

```
IDEALIIZED LRC ELLIPTICAL BODY-INTERDIGITATED FINS.
$INPUT
CRP=3.6, B2=3.6,CRPV=3.6, B2V=3.6, NCRX=1,
BIL=3.6, RB=3.129, RA=1.043,
PHIDIH=30., THETIT=22.545,
XWLF=24.4,
NCW=2, MSWR=4, MSWU=4, NBDCR=8, NCWB=2,
NBDCR=16,
ALFAC=10.0, FMACH=1.7, PHI=0.,
SREF=12.567, REFL=3.464106,
NVRTX=6,
LVSWP=1, NOLINP=1,
NOUT=0,
NBDYPR=1,
NDRAG=0,
XM=16.8,ZM=0.0,
$END
0.0         45.0        0.0
1.0         45.0        0.0
2.0         45.0        0.0
3.0         14.03624    0.0
3.6         14.03624    0.0
0.0         45.0        0.0
1.0         45.0        0.0
2.0         45.0        0.0
3.0         14.03624    0.0
3.6         14.03624    0.0
 1.52        2.4609     1.8809
-1.52       -2.4609     1.8809
 0.47179     4.41828    0.661
-0.47179    -4.41828    0.661
  0.59704    4.38465     0.0
 -0.59704   -4.38465     0.0
        0          0
        0
ZZZZZZZZZZ
```

Figure 33.- Input of program DEMON2, second case, step 10.

```
IDEALIZED LRC ELLIPTICAL BODY-INTERDIGITATED FINS.
$INPUT
CRP     = .36E+01,                         SREF    = .12567E+02,
SWLEP   = 0.0,                             REFL    = .3464106E+01,
SWTEP   = 0.0,                             PHIDIH  = .3E+02,
NCW     = 2,                               THETIT  = .22545E+02,
MSWR    = 4,                               XMLE    = .244E+02,
MSWL    = 0,                               NOLINP  = 1,
ALFAC   = .1E+02,                          NOUT    = 0,
PHI     = 0.0,                             NPR     = 0,
B2      = .36E+01,                         NDRAG   = 0,
FMACH   = .17E+01,                         NVRTX   = 6,
LVSWP   = 1,                               NPRESS  = 0,
FAC     = .95E+00,                         VRTMAX  = .35E+00,
NFVNPR  = 0,                               NCWB    = 2,
TOLFAC  = .1E+01,                          NAGAIN  = 0,
MSWU    = 4,                               BIL     = .36E+01,
MSWD    = 0,                               ITAIL   = 0,
SWLEV   = 0.0,                             NVRTPL  = 0,
SWTEV   = 0.0,                             NBDYPR  = 1,
CRPV    = .36E+01,                         NTPR    = 0,
B2V     = .36E+01,                         NTDAT   = 0,
NCRX    = 1,                               NCWT    = 0,
RB      = .3129E+01,                       NCPOUT  = 0,
RA      = .1043E+01,                       NVLIN   = 0,
ERATIO  = .3E+01,                          XSTART  = 0.0,
NBDCP   = 16,                              JCPT    = 0,
DELR    = 0.0,                             FKLE    = .5E+00,
DELL    = 0.0,                             FKSF    = .5E+00,
DELU    = 0.0,                             XM      = .168E+02,
DELD    = 0.0,                             ZM      = 0.0,
                                           $END
```

Figure 34.- Output of program DEMON2, second sample case, step 10.

WING 1 SURFACE

SPECIFIED SPANWISE LOCATIONS OF OUTBOARD PANEL EDGES AND SWEEP ANGLES.

K	Y OR Z	L.E. SWEEP ANGLE	T.E. SWEEP ANGLE
1	0.00000	45.00000	0.00000
2	1.00000	45.00000	0.00000
3	2.00000	45.00000	0.00000
4	3.00000	14.03624	0.00000
5	3.60000	14.03624	0.00000

WING 3 SURFACE

1	0.00000	45.00000	0.00000
2	1.00000	45.00000	0.00000
3	2.00000	45.00000	0.00000
4	3.00000	14.03624	0.00000
5	3.60000	14.03624	0.00000

WING GEOMETRY

TIP CHORD = 1.20000

ROOT CHORD = 3.60000

WING SEMISPAN = 3.60000

FLOW CONDITIONS

MACH = 1.70000 ALPHAC= 10.00000 PHI = 0.00000 ALFA = 10.00000 BETA = 0.00000

CRPT = 3.60000
CRPTV = 3.60000

BODY UNDER CONSIDERATION HAS ELLIPTICAL CROSS SECTION.
INTERFERENCE SHELL HAS FOLLOWING PROPERTIES:
HORIZONTAL SEMI-AXIS = 3.12900
VERTICAL SEMI-AXIS = 1.04300

Figure 34.- Continued.

TWO DIMENSIONAL VORTEX STRENGTHS AND FIXED COORDINATES IN CROSS FLOW PLANE

IVRTX	GAMMA/VINF	YVRTX	ZVRTX
1	1.52000	2.46090	1.88090
2	-1.52000	-2.46090	1.88090
3	.47179	4.41828	.66100
4	-.47179	-4.41828	.66100
5	.59704	4.38465	0.00000
6	-.59704	-4.38465	0.00000

CONTROL POINT COORDINATES FOR 2 CHORDWISE BY 4 SPANWISE PANELS ON WING 1 OR R, 0 SPANWISE ON WING 2 OR L
AND 4 SPANWISE PANELS ON WING 3 OR U, 0 SPANWISE ON WING 4 OR D

J	X(J)	Y(J)	Z(J)	BU(J)	BV(J)	BW(J)	VVRTX	WVRTX
1	1.95839	2.36879	1.04983	-.22304E-01	-.22928E+00	-.24470E-01	.35000E+00	-.16737E+00
2	3.52183	2.36879	1.04983	-.99857E-02	-.21752E+00	-.13710E-01	.35000E+00	-.16737E+00
3	2.47667	3.22373	1.54343	-.35266E-02	-.12948E+00	.35743E-01	.16981E+00	.90173E-01
4	3.54651	3.22373	1.54343	-.37760E-01	-.92972E-01	.72383E-01	.16981E+00	.90173E-01
5	2.82377	4.11189	2.05621	.89070E-02	-.83780E-01	.30039E-01	-.44104E-01	.38832E-01
6	3.56304	4.11189	2.05621	.49493E-02	-.77348E-01	.30450E-01	-.44104E-01	.38832E-01
7	2.92985	4.81185	2.46033	.11607E-01	-.62414E-01	.21053E-01	-.52146E-01	.36886E-01
8	3.56809	4.81185	2.46033	.10375E-01	-.61533E-01	.22700E-01	-.52146E-01	.36886E-01
9	1.95839	2.36879	-1.04983	.66523E-01	.18515E+00	.39039E-01	-.56348E-01	-.49656E-01
10	3.52183	2.36879	-1.04983	.16705E-01	.18064E+00	.86807E-02	-.56348E-01	-.49656E-01
11	2.47667	3.22373	-1.54343	.46956E-01	.76537E-01	.78011E-01	.57644E-02	-.82758E-01
12	3.54651	3.22373	-1.54343	.45032E-01	.65613E-01	.78516E-01	.57644E-02	-.82758E-01
13	2.82377	4.11189	-2.05621	.18352E-01	.54070E-01	.53548E-01	.43949E-01	-.47547E-01
14	3.56304	4.11189	-2.05621	.33221E-01	.32119E-01	.60967E-01	.43949E-01	-.47547E-01
15	2.92985	4.81185	-2.46033	.19116E-01	.32005E-01	.44612E-01	.43341E-01	-.22704E-01
16	3.56809	4.81185	-2.46033	.17010E-01	.32962E-01	.43647E-01	.43341E-01	-.22704E-01

CONTROL POINT COORDINATES FOR BIP*B (WING FRAME)

J	X(J)	Y(J)	Z(J)	THU(J)	THV(J)	THW(J)
17	1.71000	2.90725	.26764	0.	0.	0.
18	1.71000	2.32228	.67428	0.	0.	0.
19	1.71000	1.31938	.91568	0.	0.	0.
20	1.71000	.33985	1.03055	0.	0.	0.
21	1.71000	.33985	-1.03055	0.	0.	0.
22	1.71000	1.31938	-.91568	0.	0.	0.
23	1.71000	2.32228	-.67428	0.	0.	0.
24	1.71000	2.90725	-.26764	0.	0.	0.
25	3.51000	2.90725	.26764	0.	0.	0.
26	3.51000	2.32228	.67428	0.	0.	0.
27	3.51000	1.31938	.91568	0.	0.	0.
28	3.51000	.33985	1.03055	0.	0.	0.
29	3.51000	.33985	-1.03055	0.	0.	0.
30	3.51000	1.31938	-.91568	0.	0.	0.
31	3.51000	2.32228	-.67428	0.	0.	0.
32	3.51000	2.90725	-.26764	0.	0.	0.

Figure 34.- Continued.

LOADING INFORMATION

MACH NUMBER =	.17000E+01
ANGLE OF ATTACK =	10.000 DEGREES
SIDE SLIP ANGLE =	0.000 DEGREES
WING AREA =	14.88000
REFERENCE AREA =	12.56700
REFERENCE LENGTH =	3.46411
EXPOSED WING SPAN B =	7.20000
MOMENT CENTER: XM =	16.80000
ZM =	0.00000

U/VINF TYPE LOADING PRESSURE

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF, SHELL
DEFL, ANGLE DEG, =		0.00000	0.00000	0.00000	0.00000	
CTHR =	0.	0.	0.	0.	0.	
CZ =	.79276E+00	.15868E+00	.28077E+00	.28077E+00	.15868E+00	-.86142E-01
CY =	.44409E-15	-.91614E-01	-.16210E+00	.16210E+00	.91614E-01	0.
CM =	-.24358E+01	-.49867E+00	-.84948E+00	-.84948E+00	-.49867E+00	.26055E+00
CLN =	.17764E-14	.28791E+00	.49044E+00	-.49044E+00	-.28791E+00	0.
CLL =	0.	-.23775E+00	.33936E+00	-.33936E+00	.23775E+00	0.

FOLLOWING ARE IN WIND-AXIS SYSTEM

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF, SHELL
CL =	.78071E+00	.15627E+00	.27650E+00	.27650E+00	.15627E+00	-.84834E-01
CYWIND =	.44409E-15	-.91614E-01	-.16210E+00	.16210E+00	.91614E-01	0.
CDI =	.13766E+00	.27554E-01	.48755E-01	.48755E-01	.27554E-01	-.14958E-01
CDI/CL**2 =	.22585E+00					
CMWIND =	-.24358E+01	-.49867E+00	-.84948E+00	-.84948E+00	-.49867E+00	.26055E+00
CLNWIND =	-.17764E-14	.32482E+00	.42406E+00	-.42406E+00	-.32482E+00	0.

NOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW IS SUPERSONIC

Figure 34.- Continued.

PRESSURE LOADINGS EXCLUDE VORTEX INDUCED COMPONENTS PARALLEL TO WING SURFACES

VELOCITIES AND BERNOULLI PRESSURES AT CONTROL POINTS IMMEDIATELY ABOVE AND BELOW HORIZONTAL WING SURFACE

J	X(J)	Y(J)	Z(J)	UTOTA	VTOTA	WTOTA	PRESSA	UTOTB	VTOTB	WTOTB	PRESSB
1	1.958387	2.368794	1.049832	-.060417	-.244603	-.114140	.095448	.039836	-.222632	-.114140	-.095562
2	3.521828	2.368794	1.049832	.029305	-.206153	-.126838	-.069335	-.039318	-.249348	-.126838	.042954
3	2.476667	3.223734	1.543432	.121688	-.143424	-.148312	-.205019	-.103367	-.143647	-.148312	.232944
4	3.546508	3.223734	1.543432	.003099	-.029810	-.089819	.016312	-.159358	-.094485	-.089819	.374784
5	2.823771	4.111893	2.056211	.213850	.015533	-.194012	-.316096	-.196036	-.183093	-.194012	.438050
6	3.563037	4.111893	2.056211	.189148	.009019	-.198712	-.286204	-.153581	-.192393	-.198712	.328900
7	2.929853	4.811851	2.460332	.199154	.047522	-.188801	-.299565	-.175940	-.172350	-.188801	.394577
8	3.568088	4.811851	2.460332	.142559	.029981	-.184547	-.222648	-.121809	-.153047	-.184547	.273116

VELOCITIES AND BERNOULLI PRESSURES AT CONTROL POINTS IMMEDIATELY TO RIGHT AND LEFT OF VERTICAL WING SURFACE

J	X(J)	Y(J)	Z(J)	UTOTR	VTOTR	WTOTR	PRESSR	UTOTL	VTOTL	WTOTL	PRESSL
9	1.958387	2.368794	-1.049832	-.048981	-.168237	.373959	-.175641	.249192	-.168237	-.034052	-.372582
10	3.521828	2.368794	-1.049832	-.044396	-.140092	.362762	-.166626	.138586	-.140092	.071778	-.265562
11	2.476667	3.223734	-1.543432	-.101947	-.198473	.283438	-.027210	.243875	-.198473	-.062978	-.369046
12	3.546508	3.223734	-1.543432	-.056798	-.131307	.209349	-.024677	.168714	-.131307	-.058905	-.276415
13	2.823771	4.111893	-2.056211	-.136484	.003334	.191478	.163305	.173188	.003334	-.145856	-.265484
14	3.563037	4.111893	-2.056211	-.129189	-.048806	.262599	.079400	.239683	-.048806	-.158975	-.345343
15	2.929853	4.811851	-2.460332	-.125169	-.018274	.196437	.135183	.163401	-.018274	-.168686	-.251941
16	3.568088	4.811851	-2.460332	-.088420	-.012932	.152513	.095937	.122440	-.012932	-.126693	-.193134

PRESSURE LOADINGS AT CONTROL POINTS

J	X(J)	Y(J)	Z(J)	DELTP,LIN.	DELTP,BERN.
1	1.958387	2.368794	1.049832	-.208505	-.191010
2	3.521828	2.368794	1.049832	.137247	.112289
3	2.476667	3.223734	1.543432	.450110	.437964
4	3.546508	3.223734	1.543432	.324916	.358472
5	2.823771	4.111893	2.056211	.819773	.754146
6	3.563037	4.111893	2.056211	.685458	.615104
7	2.929853	4.811851	2.460332	.750189	.694140
8	3.568088	4.811851	2.460332	.528737	.495764
9	1.958387	2.368794	-1.049832	.596345	.196941
10	3.521828	2.368794	-1.049832	.365964	.098936
11	2.476667	3.223734	-1.543432	.691645	.341835
12	3.546508	3.223734	-1.543432	.451023	.251738
13	2.823771	4.111893	-2.056211	.619343	.428789
14	3.563037	4.111893	-2.056211	.737743	.424743
15	2.929853	4.811851	-2.460332	.577138	.387123
16	3.568088	4.811851	-2.460332	.421718	.289071

Figure 34.- Continued.

LOADING INFORMATION

MACH NUMBER =	.17000E+01
ANGLE OF ATTACK =	10.000 DEGREES
SIDE SLIP ANGLE =	0.000 DEGREES
WING AREA =	14.88000
REFERENCE AREA =	12.56700
REFERENCE LENGTH =	3.46411
EXPOSED WING SPAN H =	7.20000
MOMENT CENTER: XM =	16.80000
ZM =	0.00000

BERNOUILLI TYPE LOADING PRESSURE

	TOTAL	FIN 1 OR R	FIN 2 OR L	FIN 3 OR U	FIN 4 OR D	INTERF. SHELL
DEFL. ANGLE DEG. =		0.00000	0.00000	0.00000	0.00000	
CTHR =	0.	0.	0.	0.	0.	
CZ =	.48572E+00	.15017E+00	.13576E+00	.13576E+00	.15017E+00	-.86142E-01
CY =	0.	-.86703E-01	-.78379E-01	.78379E-01	.86703E-01	0.
CM =	-.15093E+01	-.47168E+00	-.41326E+00	-.41326E+00	-.47168E+00	.26055E+00
CLN =	0.	.27232E+00	.23859E+00	-.23859E+00	-.27232E+00	0.
CLL =	0.	-.22411E+00	.17658E+00	-.17658E+00	.22411E+00	0.

FOLLOWING ARE IN WIND-AXIS SYSTEM

CL =	.47834E+00	.14789E+00	.13369E+00	.13369E+00	.14789E+00	-.84834E-01
CY-IND =	0.	-.86703E-01	-.78379E-01	.78379E-01	.86703E-01	0.
CDI =	.84344E-01	.26078E-01	.23574E-01	.23574E-01	.26078E-01	-.14958E-01
CDI/CL**2 =	.36862E+00					
CM-IND =	-.15093E+01	-.47168E+00	-.41326E+00	-.41326E+00	-.47168E+00	.26055E+00
CLN-IND =	0.	.30710E+00	.20431E+00	-.20431E+00	-.30710E+00	0.

NOTE: L.E. OF LEAD PANEL IN FIRST CHORDWISE ROW IS SUPERSONIC

****

AFT OF LEADING EDGE OF FIN ROOTCHORDS

Figure 34.- Continued.

PRESSURE COEFFICIENTS AT POINTS ON BODY MERIDIANS

J	THETA, DEG.	XB	YB	ZB	UTOT	VTOT	WTOT	CP,LIN.	CP,BERN.	DR/DX	P/PINF, BERN.	P/PINF, LIN.
					BODY RING# 1							
1	5.63625	26.11000	2.90725	.26764	.00124	-.00456	-.06231	-.00247	.01547	0.00000	1.03129	.99500
2	16.90875	26.11000	2.32228	.67428	.02845	-.06340	-.18355	-.05691	-.03014	0.00000	.93903	.88487
3	50.63625	26.11000	1.31938	.91568	-.03987	.14166	-.18536	.07973	.09247	0.00000	1.18768	1.16130
4	84.36375	26.11000	.33985	1.03055	.01492	.00238	-.21697	-.02983	-.00133	0.00000	.99732	.93965
5	298.09125	26.11000	.33985	-1.03055	.05091	.03787	-.14973	-.10182	-.07077	0.00000	.85684	.79402
6	331.81875	26.11000	1.31938	-.91568	.01217	.05166	-.13975	-.02435	.00221	0.00000	1.00448	.95075
7	343.09125	26.11000	2.32228	-.67428	.23305	.00596	-.04719	-.46610	-.34416	0.00000	.30376	.05708
8	354.36375	26.11000	2.90725	-.26764	.11716	-.04363	-.05913	-.23432	-.19382	0.00000	.60789	.52597
					BODY RING# 2							
1	5.63625	27.91000	2.90725	.26764	-.04536	.21072	-.21777	.09073	.07482	0.00000	1.15136	1.18354
2	16.90875	27.91000	2.32228	.67428	-.05182	-.01007	-.16570	.10365	.14193	0.00000	1.28712	1.20968
3	50.63625	27.91000	1.31938	.91568	-.02660	.13444	-.17723	.05321	.06675	0.00000	1.13504	1.10764
4	84.36375	27.91000	.33985	1.03055	-.04515	-.00781	-.19347	.09031	.12675	0.00000	1.25642	1.18269
5	298.09125	27.91000	.33985	-1.03055	.00594	-.00849	-.14352	-.01189	.01765	0.00000	1.03571	.97595
6	331.81875	27.91000	1.31938	-.91568	.00849	.02511	-.13126	-.01698	.01101	0.00000	1.02228	.96564
7	343.09125	27.91000	2.32228	-.67428	.16337	.06735	-.04384	-.32673	-.26430	0.00000	.46532	.33902
8	354.36375	27.91000	2.90725	-.26764	.14197	-.06378	-.07977	-.28393	-.22945	0.00000	.53582	.42560

Figure 34.- Concluded.

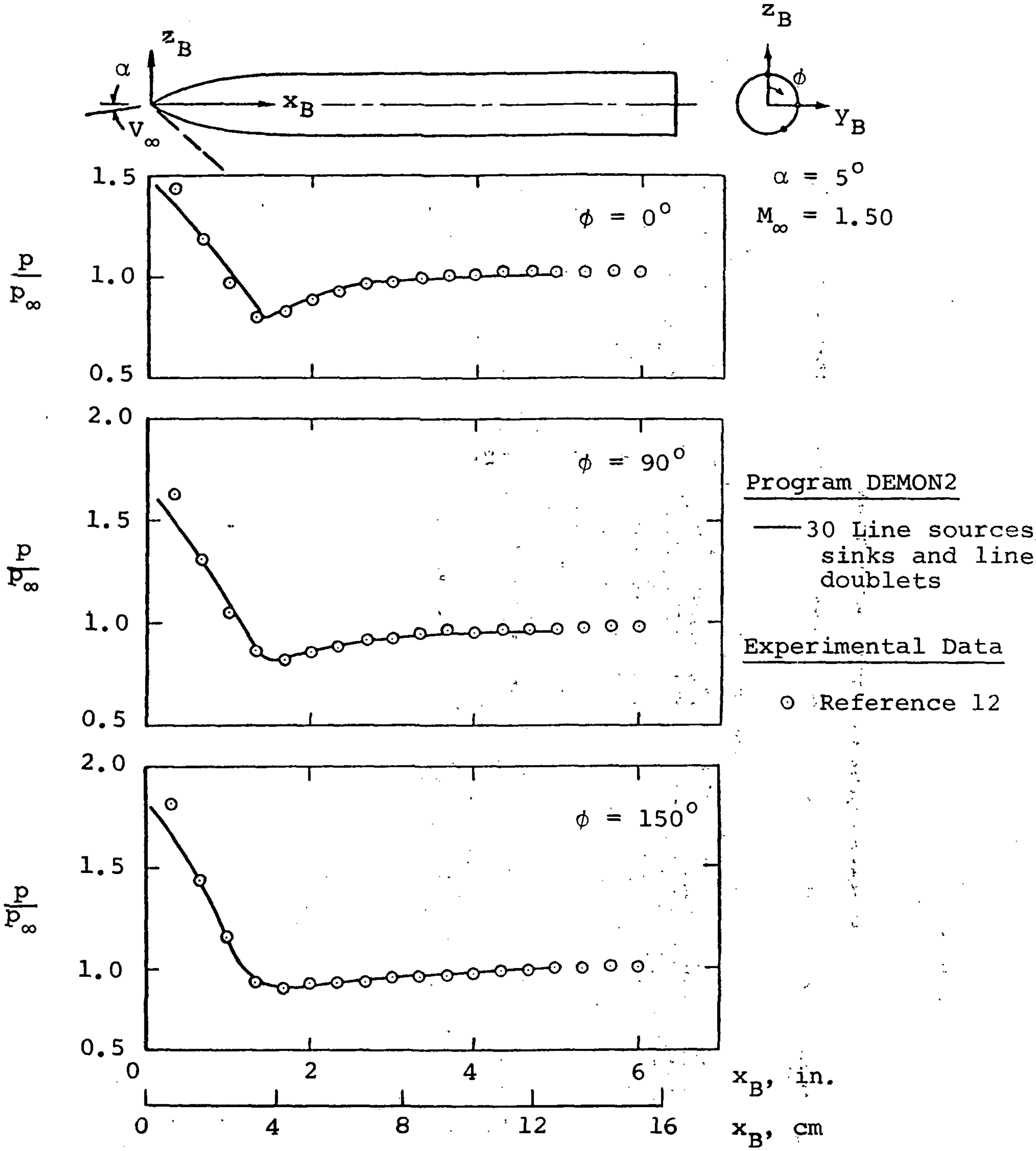


Figure 35.- Pressure distribution on ogive cylindrical body in uniform flow; $M_\infty = 1.50$.

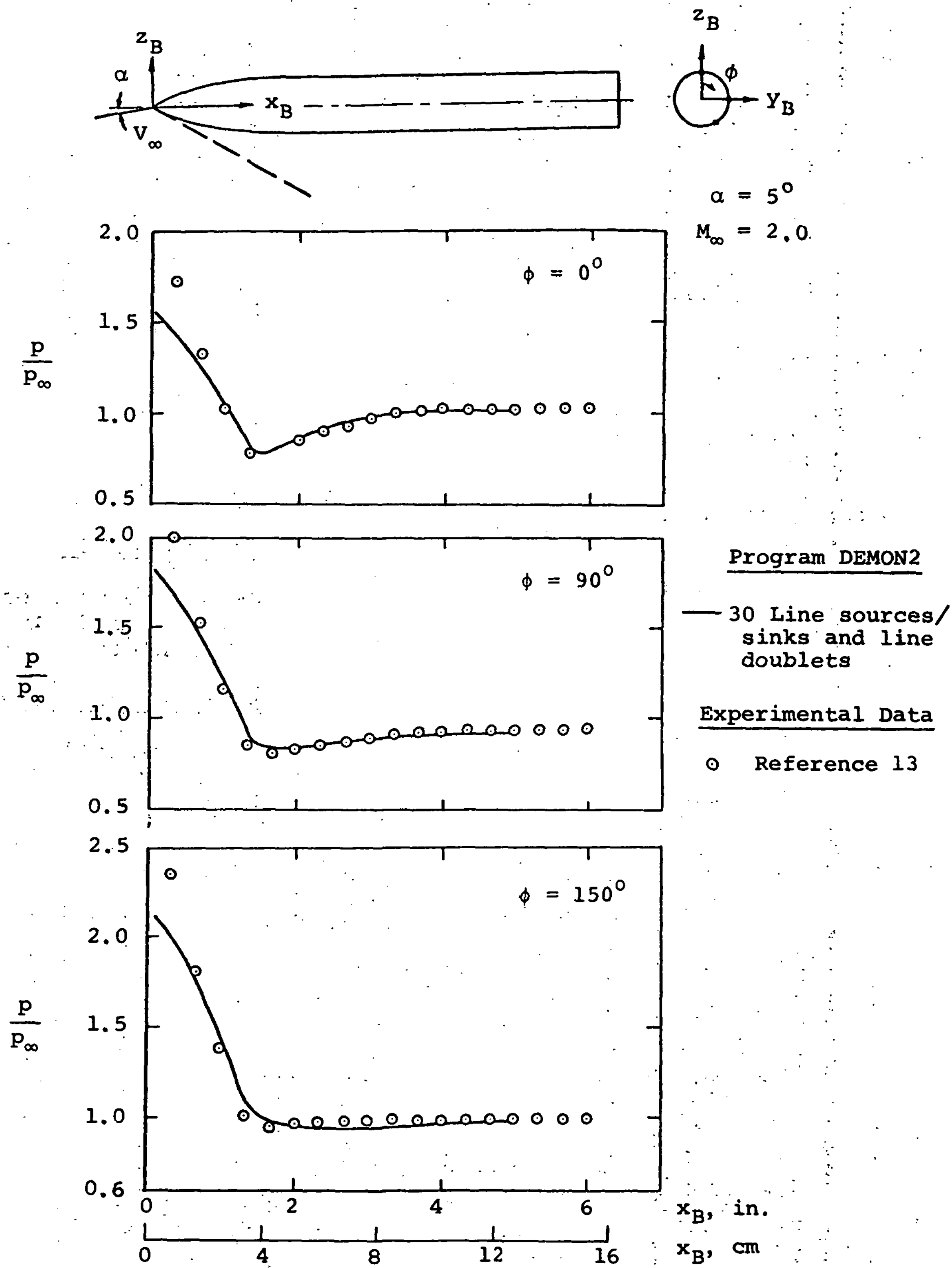


Figure 36.- Pressure distribution on ogive cylindrical body in uniform flow; $M_\infty = 2.0$.

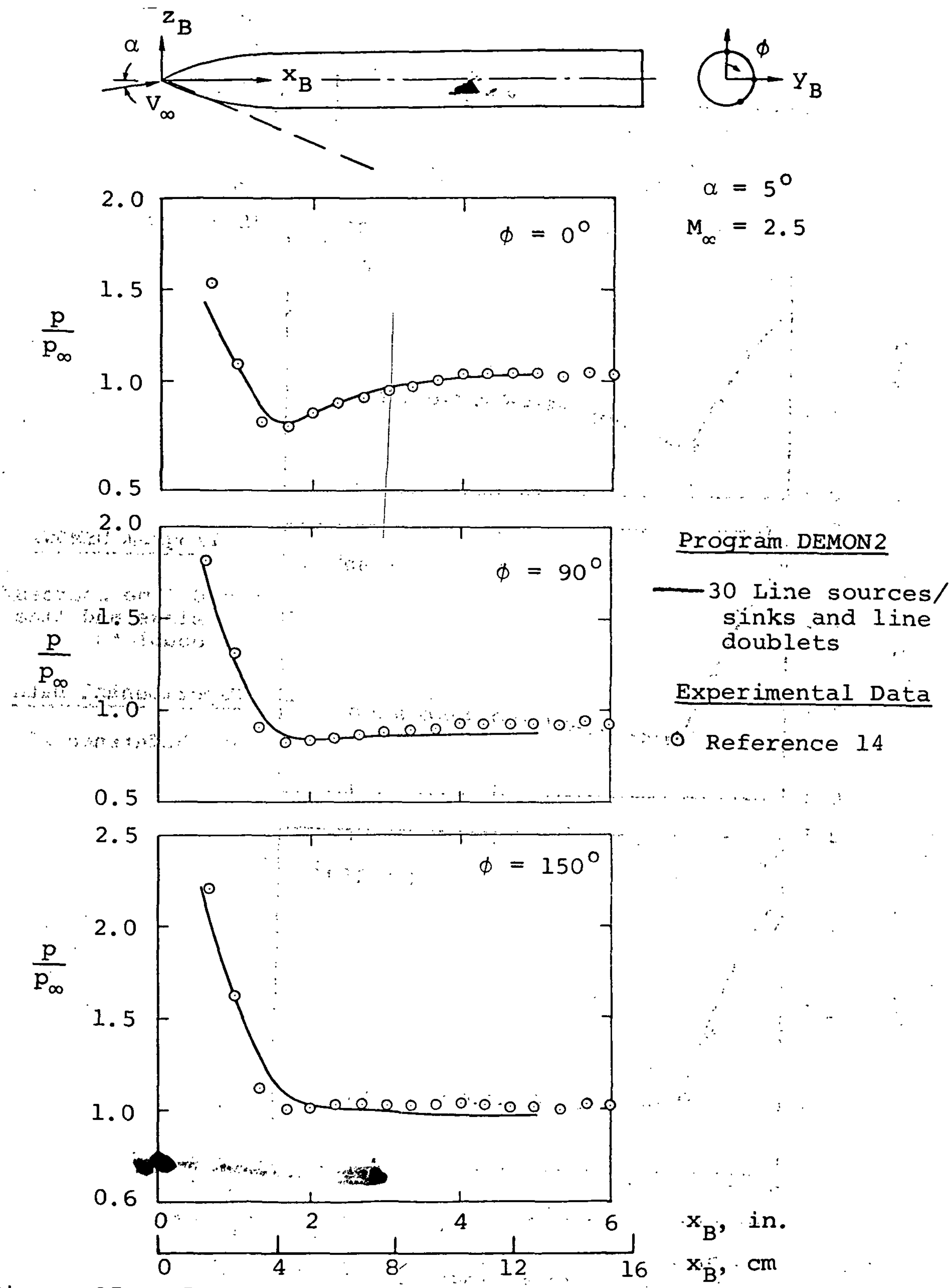


Figure 37.- Pressure distribution on ogive cylindrical body in uniform flow; $M_\infty = 2.5$.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA CR-3122		

4. Title and Subtitle	5. Report Date
COMPUTER PROGRAMS FOR CALCULATING PRESSURE DISTRIBUTIONS INCLUDING VORTEX EFFECTS ON SUPERSONIC MONOPLANE OR CRUCIFORM WING-BODY-TAIL COMBINATIONS WITH ROUND OR ELLIPTICAL BODIES	April 1979
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Marnix F. E. Dillenius and Jack N. Nielsen	NEAR TR 154
9. Performing Organization Name and Address	10. Work Unit No.
Nielsen Engineering & Research, Inc. 510 Clyde Avenue Mountain View, CA 94043	
	11. Contract or Grant No.
	NAS1-14495
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Aeronautics & Space Administration Langley Research Center Hampton, Virginia 23665	Contractor Report 7/1/76-7/1/78
	14. Sponsoring Agency Code

15. Supplementary Notes

Langley Technical Monitor: Wallace C. Sawyer
Final Report

16. Abstract

Computer programs are presenteu capable of calculating detailed aerodynamic loadings and pressure distributions acting on pitched and rolled supersonic missile configurations which utilize bodies of circular or elliptical cross sections. The applicable range of angle of attack is up to 20°, and the Mach number range is 1.3 to about 2.5. Effects of body and fin vortices are included in the methods, as well as arbitrary deflections of canard or fin panels.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
cruciform missiles supersonic flow, elliptical bodies wing-body interference wing-body-tail interference missile aerodynamics	[redacted]

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	633	

[redacted]